A Semimonthly Technical Newspaper

Metallurgical & Chemical Engineering

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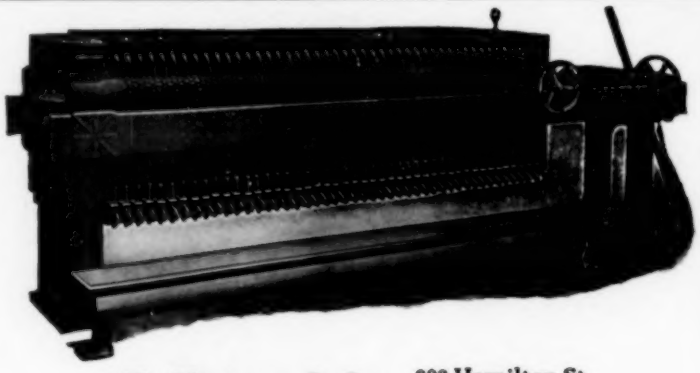

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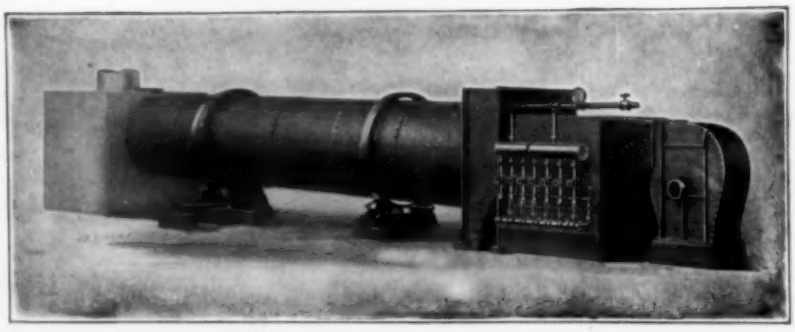

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Notice of Removal

The publication offices of METALLURGICAL & CHEMICAL ENGINEERING *have been removed to the new building of the McGraw-Hill Publishing Company, Tenth Avenue at Thirty-sixth Street, New York. All future communications for editorial and business departments should be sent to that address.*

A Time for Patriotism

Our country is at war—at war with a foe who will be defeated only by a supreme, united and concentrated effort. This fact must sink so deeply into the consciousness of every American that it will become the animus of all his acts and the dominating passion of his daily life. Henceforth we must have but one object until it is attained. The great need of the hour is an aroused patriotism that will wipe out prejudice and selfishness, encourage sacrifice and service and unify our every effort.

As a contribution to the attainment of this end we are sending to our readers as a supplement to this issue of METALLURGICAL & CHEMICAL ENGINEERING a colored poster bearing a legend of vital import. The question there asked should concern not only manufacturer, dealer or workman, but also every citizen who is capable of doing more for the protection of "my boy."

Distribution of Niagara Power

In line with the Government's policy to apply the resources of the country most effectively to the winning of the war, we are about to witness official redistribution of Niagara power. Next to an increase in power at that strategic point, the necessity of which we are now sadly appreciating, we presume that a redistribution of such power as we have among the essential industries is the logical step. Certain it is that if the Government is going to demand ferro-alloys and other materials requiring electric power for their production, it must take steps to assure the industries making such materials a supply of power adequate for their needs. And since the total amount of power available is limited to a known quantity, there remains nothing but a withdrawal here and there from non-essential industries and a reapportionment according to essential needs.

Canada recently appointed Sir Henry Drayton royal commissioner to investigate exportation of Canadian Niagara power and controller of the distribution and production of electrical energy in Ontario. Fearful lest there might be an embargo on power from Canada, the United States arranged for a conference between American and Canadian authorities with a view to adopting a priority agreement that would prevent inter-

ference with our making of war supplies for either country.

More recently Secretary Baker has assumed authority in the distribution of American Niagara power, and has appointed Robert Bulkley of Cleveland and Colonel Keller of the Army to make an investigation of the uses of power on this side of the boundary line. American users of power already have been asked to lay before this commission complete statements of the ultimate use and destination of their products so that a conclusion can be reached as to their relative importance for war purposes. The conclusion finally reached by the War Department will depend on the recommendations made by the commission as a result of the hearings and the statistics submitted, and on this basis there is to be a reassignment of power.

No play of fancy or stretch of imagination is required to visualize the pitiful spectacle which our power shortage must present to the enemy, especially an enemy who has shown himself so keenly alive to industrial development and who has been able to prove himself so able an antagonist through his utilization of every natural resource. Congress is about to convene. Water-power legislation is vitally necessary and should be enacted. Will Congress rise to an intelligent appreciation of the situation, or will sentimental and personal obstruction still prevail?

Opportunity for Hydrometallurgy

If this is the day of opportunity for industrial chemistry it holds no less promise for hydrometallurgy. Increased waste and metal loss in lead smelting and zinc smelting, due to the increase in quantity of complex ores treated, is bound to demand attention in the near future; and the success of hydrometallurgy in solving some of the past problems in ore treatment suggests a continuation of that line of attack. In many cases "waste" or "metal loss" represents loss of money in transportation and treatment cost rather than actual loss of metal. As a particular example of this we have the shipment of zinc ores and concentrates containing gold, silver, lead or copper, from Montana and Idaho to Kansas, Missouri or Oklahoma for recovery of zinc, followed by reshipment of the residues to the Rocky Mountain region for extraction of the other metals, and the final shipment of the Western products to Eastern refineries. Another instance of economic loss is found in the treatment of zinky ores and flotation concentrates at lead smelters.

Zinc retort residues from Western ores contain from 30 to 40 per cent carbon, 8 to 10 per cent lead, 6 to 7 per cent zinc, and probably as high as 30 oz. silver per ton. Ordinary methods of concentration have failed to handle this material satisfactorily. Some of it is now burned in heaps in the open air, to remove much of the carbon and put the balance in good physical condition for the blast furnace. This is done without any appreciable loss of metal, and the weight is greatly reduced by the loss of carbon. There remains, however, a large amount of useless gangue with little or no fluxing value, on which freight and treatment costs must be paid. The zinc content is not only troublesome to the lead smelter, but becomes tied up in the slag.

The continued improvement of the flotation process has increased the recovery from low-grade complex ores and has reduced the cost of operation, but the problem of simultaneously separating the constituent minerals has not been solved satisfactorily; and in the minds of some metallurgists we cannot hope for the accomplishment of this end by any form of preferential flotation. A flotation concentrate is not an ideal product for the producer, the railroad, or the smelter to handle, but with modern processes of roasting and sintering it can be put in good condition for the lead blast furnace without serious loss in dust or fume. Nevertheless, increased recovery by flotation means the increased recovery of all the constituent minerals, and this means a zinky product for the lead smelter, relatively lower in lead and higher in silver than a normal concentrate. Again we have a temporary loss of zinc in the slag.

The increasing amount of zinc received at Western lead smelteries from the sources just considered, retort residues and flotation concentrates, is unquestionably increasing the "loss" of this metal in lead slags. This loss probably is due as much to the physical as to the chemical composition of the slag, and would afford an interesting subject for research. Added to the metal loss is the increased mechanical difficulty of operating the furnaces, which necessarily means an increased cost of operation, however small it may be. In any event, we have metal temporarily tied up in the slag, possibly for the next generation to recover, just as the slag dumps of the past have been resmelted at a profit by the present generation.

There are a number of millions of tons of old slag at the lead smelteries of the Rocky Mountain region that probably will contain an average of 100 pounds of zinc, 15 to 20 lb. of lead, and ½ to ¾ oz. silver to the ton. Slags produced to-day will contain an additional 25 to 50 lb. of zinc, 5 to 7 lb. of lead, and ¼ oz. of silver per ton. In the aggregate these losses represent a considerable value.

In the light of these facts, we have two problems: First, to treat complex ores at a common point by a new process, to which retort residues also might be amenable. Second, to develop a process that will successfully recover the valuable metals in lead blast furnace slags. The only feasible method of meeting the physical and chemical conditions involved seems to be one of a hydrometallurgical nature. The treatment of ores at or near their source is being done successfully at Great Falls and at other points in the Northwest, and on or near the Pacific coast. Many troublesome problems have been solved under the beneficial effect of war-time prices for chemically pure products, and the momentum thus acquired probably has carried some of the projects over the shoals of difficulty and expense usually encountered in new processes. There re-

main, however, enough unsolved problems to tax the ingenuity and reward the industry of those who are willing to make the effort.

Reducing the Unessentials

Washington dispatches do not overdraw the proprieties of the case when they assert that the Government authorities intend to proceed very circumspectly in their efforts to curtail unessential industrial activities and to keep their operations as secret as possible. Very truly it is observed that publicity in such matters would tend to disturb business generally and add to the injury of the industries involved.

This procedure of curtailing the unessentials completes the operation of "playing both ends against the middle." The positive operation consists in placing Government orders and requiring that priority be given in their filling, while the negative operation consists in prohibiting operations in various unessential activities. Thus few are going to escape Government regulation by the one means or the other.

A few business men inquired of Washington by what authority this procedure of curtailment was to be undertaken, and received answers equally brief and adequate. The Government has full authority under the Lever act to control the supply of fuel to any industry, while it likewise has power to regulate the railroad movement of raw material to a plant and finished product from it, while under the new draft regulations the employees of an industry are to be classified according to the importance or unimportance of the industry with respect to its contributing to the winning of the war.

It is to be hoped that the operation of regulation will be conducted by the co-operative method. The representatives of the Government and of the industries in question should meet and lay their cards on the table. There should be the utmost frankness on each side. Then, too, it should be remembered that many of our captains of industry owe their success largely to their ability to move a man from one job to another whereby he has become more useful to the organization. The industry that is deemed unessential should be found another job, in which it can help win the war. To a great extent war conditions, operating through natural channels, are serving to assist in the readjustments desired. Many of the things deemed unessential are things for which the demand naturally decreases at this time. Jewelry and watch makers see prospects of their trade decreasing and seek employment in making the finer parts of shells. So far as shop work is concerned, our American methods of standardized construction and interchangeability of parts lend themselves naturally to these changes in industrial operations. The Liberty motor, drawing its parts from many places, is an accomplished fact in this connection, and Henry Ford has been intrusted with a corresponding task in the matter of building standardized ships through the Emergency Fleet Corporation. In turn jobs should be found, if at all possible, for the factories making furniture, musical instruments and other things.

A difficult aspect of the case is the conflicting nature of the two prime desiderata in the program of curtailing in the unessentials. One object is to relieve the burden now resting upon the railroads, and which has badly congested them in the Central West. Another object is the release of labor, to provide more labor elsewhere or to lessen the disturbance caused by the successive drafts to the colors. Now, the industry that involves a large freight movement in its conduct is an industry that, as a rule, employs relatively little labor in its operations, while the industry that employs much labor is usually one that involves relatively little freight movement. It is the one thing or the other, the large volume of material handled, or the large amount of work done upon the material, that makes an industry important from the standpoint of its annual turnover in value. No large number of industries can be selected that would, by curtailment, release both a large amount of freight movement and a large volume of labor.

The burden upon the railroads has not been exaggerated. There is no doubt that the volume of freight offered for transport should be reduced, until the time arrives when the capacity of the railroads can be increased, as by the supply of additional locomotives, or otherwise, for the railroads have become congested and are hauling day by day less freight than would be the case if somewhat less freight had been offered them. This is not the whole story, however. An important economic waste has arisen from the railroad situation, and one that has received little if any public attention, certainly not the attention it deserves. Freight movement requires not merely the physical elements of cars, engines and tracks. It requires also brains and (or) clerical work. It is common gossip, and a fact testified to by many in position to know, that with rising salaries and wages throughout the country, railroads have let valuable men go from their office forces by reason of arbitrary limits set to the salaries which given jobs should pay, often resulting in one $100 man being allowed to go while eventually his work has come to be done by two $75 men. That is an economic waste. Arising from inefficiency in office forces of the railroads there has come another economic waste. In the exigencies of the case shippers in order to secure freight movement have employed high-class men to keep in touch with the movement of their commodities, frequently to make a personally conducted tour with a carload or trainload of freight. The shipper gets results and is willing to pay the price, but when both labor and brains are scarce these practices should be made unnecessary. The clerical forces in the railroad offices should be made adequate to securing the fullest performance from the physical facilities, in cars, locomotives and track, and railroad operations should be so conducted that employees of shippers who are overlooking or personally conducting freight movements can be given other work.

Readers' Views and Comments

The Richards Pulsator Jig in Modern Concentration of Colorado Tungsten Ores

To the Editor of Metallurgical & Chemical Engineering

SIR:—In an article entitled "Modern Concentration of Colorado Tungsten Ores," by S. Fischer, Jr., published in METALLURGICAL & CHEMICAL ENGINEERING, May 15, 1917, we find the following statement:

"Where rich ores are milled, as at the Wolf Tongue Mill, the Richards type of jig works very satisfactorily. It may be said with certainty that the majority of the up-to-date mills use the Harz in preference to the Richards jig."

Mr. Fischer's article may have been compiled some time before May 15, 1917, the date of the article referred to, which led him to state that "the majority of the up-to-date mills use the Harz in preference to the Richards jig," for now nearly all the larger up-to-date mills in the Boulder district have replaced the Harz with the Richards pulsator jigs.

The following is a list of mills using the Richards pulsator jigs in the Boulder district, Colorado:

Installed.	Name of Mill.	Size of Jigs.
April 15, 1916	Duncan Mill	1 12-in. single
Aug. 3, 1916	Wolf Tongue Mill	2 12-in. in series
Sept. 13, 1916	Wolf Tongue Mill	1 6-in. single
Sept. 29, 1916	Vasco Mining Co.	2 12-in. in series
Dec. 26, 1916	Tungsten Metals Corp.	2 12-in. in series
Jan. 31, 1917	Luckie 2 Tungsten Co.	1 12-in. single
March 16, 1917	Vasco Mining Co.	1 6-in. single
April 9, 1917	Primos M. & M. Co.	1 12-in. single
April 17, 1917	Wolf Tongue Mill	2 6-in. single
April 26, 1917	Long Chance	1 6-in. single
June 6, 1917	Boulder Tungsten Min. Co.	1 6-in. single
Oct. 29, 1917	Primos Exploration Co.	2 12-in. in series

In some of these mills using Harz jigs before the installation of Richards pulsator jigs, it was the practice to remove coarse tungsten concentrate accumulating on top of the Harz jig screen by hand-skimming. This left a large amount of ore on the screen for a long period of time, resulting in a considerable production of slime, due to the suction cycle of the Harz jig.

This continual pounding of the tungsten concentrate particles on the wires of the Harz jig screen, together with attrition in the jig bed during the suction cycle, allowed slime particles of tungsten concentrate to escape with the tailing of the Harz jig, thus increasing the loss of mineral throughout the mill operations.

A further disadvantage in the use of Harz jigs, involving the suction water cycle, was that the hutch concentrate would not assay over 30 to 35 per cent WO_3, which is too low grade for shipment, and required sending this product to concentrating tables for retreatment. The suction cycle of the Harz jig draws not only tungsten mineral particles down through the screen into the hutch, but also draws down sand particles which lower the grade of concentrate.

The Richards pulsator jig uses a pulsion water cycle only—no suction cycle—resulting in a loose bed above the screen, allowing very rapid settling of mineral particles and reducing attrition and consequent sliming to a minimum. The concentrate particles discharged from the Richards pulsator jig are sharp and not rounded.

The use of the pulsion cycle only in the Richards jig allows only the heavy mineral particles to fall through the screen into the hutch, thus insuring high-grade concentrate. Instead of a 30 or 35 per cent WO_3 hutch concentrate from the Harz jig, an average of 60 per cent WO_3 hutch concentrate is produced by the Richards pulsator jig, and in some cases as high as 69 per cent WO_3.

In the Boulder district the 12-in. size Richards pulsator jigs are usually applied to the treatment of tungsten ore (ferberite) with feed particles varying from 6 to 8 millimeters maximum diameter to about 1.5 millimeters minimum diameter. Coarse concentrate from above the screen varies from 55 to 65 per cent WO_3. Hutch product produced varies from 60 to 70 per cent WO_3.

A noteworthy example of the application of Richards pulsator jigs to the concentration of pulp usually treated on cencentrating tables of the reciprocating type is found in the use of the 6-in. Richards jigs listed in the above table. These 6-in. jigs treat —1.5 millimeter to 0 pulp, the jig tailing being retreated on concentrating tables. The gates above the screen deliver concentrate assaying 55 to 60 per cent WO_3. The hutch product from these 6-in. jigs assays about 65 per cent WO_3.

In one large mill of the Boulder district the use of these 6-in. jigs, treating the —1.5 millimeter to 0 pulp allowed the removal of two slime tables from the mill and the load on the reciprocating tables was greatly reduced. The concentrate contained a large proportion of mineral grains of a size as fine as 100 or 200-mesh. This is a remarkable result for concentration by jigs and opens a wide field for concentrating fine pulp of ores other than tungsten ores. In this same mill the Richards pulsator jigs produce 60 per cent of all the concentrate recovered in the mill.

Mr. De Witt, superintendent of the Wolf Tongue Mill, Nederland, Col., stated that in connection with the installation of Richards pulsator jigs they "were repaid for all expense in less than 30 days."

The Richards pulsator jig is a most important factor in bringing about the recent improvements in the mills of Boulder County for the concentration of tungsten (ferberite) ores. The result is not only increased capacity, but greatly increased recovery of mineral. The millmen of that district deserve much credit for recognizing merit in a device and using it, even though it replaces an older form of jig practice which was fixed through long established custom.

FRANK E. SHEPARD.

Denver, Colo.

Potash from Cement

To the Editor of Metallurgical & Chemical Engineering

SIR:—I have read with a great deal of interest and pleasure your excellent article on Potash, I. W. W. and the Fuel Administration. The figures you give on the cost of production in the Nebraska lake district are particularly interesting.

In this connection I would call your attention to the fact that potash can be produced at a very much lower

cost as a by-product from cement manufacture. Under present conditions our cost here is running approximately $30 per ton of pure K_2O packed on board cars. This, however, is the manufacturing cost and does not include royalty, depreciation and similar items. Under normal conditions of operation it would be possible to reduce this cost very materially, probably by as much as 50 per cent; therefore it would seem that we have here a source of potash which can compete with the German article under any conceivable market conditions.

While the present production of potash from this source is not very great, the potential possibilities are enormous especially when the use of high potash materials for the manufacture of cement is taken into consideration. At the present time there are some half dozen cement plants now installing apparatus for the recovery of by-product potash, one of which, the Clinchfield, is noted in your issue of November 15. All of these companies have been led to go into the matter by the successful example of our plant.

JOHN J. PORTER.

Security Cement and Lime Company, Hagerstown, Md.

Power From Coal

To the Editor of Metallurgical & Chemical Engineering

SIR:—I was especially interested in the power discussion in your issue of Oct. 15. It is easy to agree with those who hold that water power offers the logical solution for the power shortage. At these times, the most portentous in the history of the world, with so much depending on the electrochemical industries, what wanton waste there is in the spectacle of four or five million horsepower idling in the cataract of Niagara!

Mr. Dow in his article on the "Production of Electricity by Steam Power" holds out no hope for the relief of the electrochemical industries through the medium of steam power. The great losses of heat in the production of power through steam being: "The losses necessary to give the necessary draft and the big losses of heat thrown overboard (in the condensing water)—they seem to be inherent in steam." These two major losses constitute about 80 per cent of the heat value of the fuel. Surely a sad situation; for in the case of just one great power-generating station in New York City the equivalent of 2000 tons of coal is wasted daily because of these two heat losses!

I suggest a scheme to save the greater part of this loss. Conceive a cycle embracing:

1. A gas producer of the Mond or similar type, utilizing large quantities of steam.

2. A special steam boiler with great furnace capacity, compared with its heat-absorbing surface, whose fuel is gas from the producer burning in a closed furnace under a pressure of say 150 lb. per sq. in.

3. A gas turbine for the main power production, utilizing as motive-fluid the high-pressure *exit gases* from the steam boiler.

By means of this arrangement I accomplish two great ends:

1. Reverse the usual method for power production through the use in the turbine of the *exit gases*—the products of combustion—and not the steam. And through the use of the latter in the producer its latent heat is largely conserved.

2. Avoid the usual loss in the sensible heat of the exit gases in the ordinary methods of steam raising.

Thus the two difficulties stated by Mr. Dow are solved, and the important by-products of the Mond producer—ammonia and tar—are realized.

The chief problem, however, in the scheme here outlined is the economical compression of both gas and air—to say 150 lb.—prior to combustion in the special closed furnace of our steam boiler. But as single-stage rotary compressors, with an efficiency of over 60 per cent, have been designed, probably the difficulty here is not insurmountable. (I doubt if the Diesel engine, with its multi-stage air compressor and its water-cooled cylinder, can compress its air at an efficiency of 60 per cent.)

With regard to the temperature of the exit gases from our boiler, which are to be conducted direct to the power turbine, this should be in the neighborhood of 1500 deg. Fahr. In arriving at this figure, I estimate that two tons of steam will be required by the producer for every ton of coal gasified, in order to develop the greatest possible amount of ammonia practicable. And the raising of two pounds of steam from every pound of coal gasified should reduce the temperature of the gases from the combustion in the boiler to about 1500 deg. Fahr., or a temperature within the working limits of a properly designed turbine. If you are afraid of this temperature you may water-cool the turbine casing and the shaft, and make your rotor of nichrome or some of the alloy steels containing chromium or tungsten, which hold their strength even at low red heat.

What do your readers think of this idea?

A. C.

Brooklyn, N. Y.

Determination of Phosphorus in High-Speed Steel

To the Editor of Metallurgical & Chemical Engineering

SIR:—The writer experienced several emotions when the contribution of Mr. Edward C. Kraus of the Atlas Crucible Steel Co., Dunkirk, N. Y., concerning the determination of phosphorus in high-speed steels appeared in the issue of METALLURGICAL & CHEMICAL ENGINEERING for Feb. 1, 1917. This "modification of present methods" was originated and used by the writer in the fall of 1913 in the laboratory of the Crucible Steel Co. of America, Sanderson Works, Syracuse, N. Y. A brief account of the circumstances leading to the development of this modification will enable competent chemists to utilize the method as given by Mr. Kraus with, perhaps, a little more rapidity, accuracy and intelligence.

In the fall of 1913 the writer was experiencing considerable difficulty in precipitating *in toto* phosphorus from high-speed steels containing about 1.00 per cent vanadium. The method then employed provided for the determination of silicon, tungsten and phosphorus from the one sample, and, in brief, was as follows: Sample was dissolved in 1.20 nitric acid, with the addition of a few cc. of conc. nitric acid. When action had ceased, 25-30 cc. HCl. were added and solution evaporated to dryness and baked one hour. Residue was taken up with conc. HCl, boiled until all iron and chromium salts were in solution, diluted, filtered and washed with 1:10 HCl. Silicon and tungsten were determined by ignition and volatilization of the precipitate. Filtrate was evaporated to 5-10 cc., diluted to 40-50 cc. and precipitated at 70 deg. to 75 deg. Centigrade with molybdic acid solution. Invariably with steels containing vanadium this method

gave low results and a very unsatisfactory "yellow precipitate," very fine, very light and orange in color rather than the "canary yellow" of the usual precipitate.

The writer read a discussion of this problem in an issue of METALLURGICAL & CHEMICAL ENGINEERING in the fall of the same year. The discussion was written by two chemists of the Government Bureau of Standards, whose names the writer cannot recall, and considered the determination of phosphorus in the presence of vanadium, with no other interfering elements present, such as tungsten. From this article the writer gleaned the following facts:

Vanadium, in the pentavalent stage, interferes with the accurate determination of phosphorus by the usual routine "yellow precipitate" method. Vanadium seems to react with the molybdic acid solution in various ways, according to the vanadium content; with a vanadium content up to 0.35 per cent, vanadium does not seem to interfere with the precipitation of phosphorus, but seems to be partly precipitated with the phosphorus giving the precipitate the orange color mentioned above, and yielding a higher calculated percentage of phosphorus than is true; with a vanadium content over 0.4 per cent vanadium interferes with the precipitation of phosphorus, but is itself precipitated as already described, but giving low results.

The vital point in the method proposed by these chemists was the reduction of vanadium from the pentavalent stage without reduction of the phosphoric acid present, and in eliminating any unnecessary excess of nitric acid, which tended to reoxidize the vanadium after it had been so reduced. The reduction was done by the use of a saturated solution of ferrous sulphate; the excess nitric acid was eliminated by neutralizing the solution with ammonia before precipitation with the molybdic acid solution.

The writer's problem was to adapt this method to a steel containing a high percentage of tungsten in addition to a comparatively high percentage of vanadium. The procedure adopted by the writer after careful experiment was as follows: Tungsten was removed as in the original method if quantitative determination was desired, otherwise sample was dissolved in 50 cc. aqua regia and evaporated to 10 cc. The writer has never found it necessary to oxidize an aqua regia solution with potassium chlorate as suggested by Mr. Kraus. The solution was diluted and tungsten filtered off and washed three or four times with 1:1 HCl. (hot). Filtrate was then evaporated nearly to dryness to drive off as much Cl. as possible, diluted to 40-50 cc., heated to 70 deg. to 75 deg. C., and removed from the hot plate. Five cc. saturated solution ferrous sulphate and 5-8 cc. of 6-8 per cent sulphurous acid were added and phosphorus precipitated by molybdic acid as quickly as possible. If vanadium content was over 1.25 per cent, 10 cc. ferrous sulphate solution and 10 cc. sulphurous acid were added, as the nitric acid present in the molybdic acid solution seemed to reoxidize vanadium when present to that extent. Some writers warn against the use of excess ferrous sulphate because of its reducing action upon the phosphoric acid present. The writer carefully investigated this phase of the problem and found no apparent loss of phosphorus by the use of ferrous sulphate as outlined above. By using this modification the writer obtained a phosphorus percentage as high as 0.056 from steels which yielded as low as 0.004 by the original method. He has had very good success in checking this modification against Government Standards as well as against other methods of eliminating the interference of vanadium.

The *raison d'etre* of this communication is to give credit to whom credit is due. The research and conclusions upon which this modification is based were the work of the two chemists of the Bureau of Standards and to them the greatest credit must be given.

W. T. SHEFFIELD.

Mohawk Improvement Co.

Meeting of New York Section, American Institute of Mining Engineers

Legislation affecting the mining and metallurgical industries was the subject of discussion at a meeting of the New York Section, A. I. M. E., Nov. 26, 1917. Taxation, price fixing, priority rulings, etc., were considered, with a view to making constructive suggestions to the Government for equitable treatment of mining and metallurgical companies.

It was clearly established that the metal industry wants to pay its share of war expense and that equitable taxation is welcome. It was quite as clearly shown, however, that the present law on excess profits taxation is unjust to mining companies as compared with manufacturing concerns. Before the meeting adjourned a telegram was addressed to the congressional committee at Washington, which is advising the Treasury Department on the construction of the law, urging that Sec. 207 of the war income tax law be construed so that "earned surplus" will include ore in place susceptible of valuation; and further that companies should be permitted to value their property as of the present irrespective of their capital stock or date of incorporation.

With regard to price fixation the general sentiment seemed to be that if the Government is to get the supply of metals it needs, it must be willing to pay prices that will insure production, and that there must be assurance that those prices will not go below a level at which operations can be conducted at a fair profit. There was some difference of opinion as to the efficacy of price fixation, owing to the intricacies of the metal-producing business which were not fully understood by the Government and which could not be taken fully into account in fixing prices. Some speakers favored no fixing of prices and free play for the laws of supply and demand.

Meeting of New York Section, Society of Chemical Industry

By-product recovery of potash from wool-scouring waste and Portland cement formed the basis of an interesting program at the regular meeting of the New York Section, Society of Chemical Industry, Nov. 23, 1917.

Mr. R. S. WESTON explained the principles underlying modern disposal of wool-scouring waste for the recovery of oils, fats, waxes and potash.

The manufacture of Portland cement was explained by Mr. E. D. BOYER of the Atlas company. The paper was supplemented by moving pictures showing the complete process of cement making from the quarrying of the rock to sacking and shipping the ground product. The recovery of potash from kiln dust was explained.

Information on Industrial Poisons

The importance of conserving labor in the present national crisis and the necessity of properly safeguarding men working in various industries, directs attention to the subject of industrial poisons. About the only information published on this subject is that secured and compiled by the Bureau of Labor Statistics, U. S. Department of Labor, with the ever-widening scope of national industry comes the disclosure of industrial poisoning and the discovery of new dangers for the workmen engaged. A recent instance is found in dope poisoning in the manufacture of airplane wings due to the use of cellulose nitrate or acetate dissolved in tetrachlorethane. Other examples are toxic jaundice in munition workers, poisoning from the exhaust gases from gasoline engines, and the more common troubles from metallurgical and chemical gases, fumes and dusts.

The wide diversity of industries in which the poison menace may occur makes the gathering of information on the subject slow and difficult. The Bureau of Labor is constantly investigating the instances that come to light, but co-operation is needed on the part of those directly concerned. For this reason we invite contributions pertinent to the metallurgical and chemical industries. Valuable information will be found in the Bureau's Bulletin 100, which classifies and lists industrial poisons and other substances injurious to health. This is now under revision, and the Bureau will appreciate co-operation in bringing it up to date.

Advisory Board of Chemists for Bureau of Mines

Because of the great amount of war work being done by the Bureau of Mines, Secretary of the Interior Lane has asked six of the prominent chemists of the country to act as an advisory board to the bureau.

The members of this board are: Dr. Wm. H. Nichols, General Chemical Company, New York, chairman of the board; Prof. H. P. Talbot, head of the chemical department of Massachusetts Institute of Technology, Boston, Mass.; William Hoskins, consulting chemist, Chicago, Ill.; Prof. H. P. Venable, head of the chemistry department, North Carolina University, Chapel Hill, N. C.; E. C. Franklin, professor of chemistry, Leland Stanford University, Stanford, Cal.; and Dr. Charles L. Parsons, chief chemist of the Bureau of Mines.

The board will discuss and advise upon gas warfare research, the minerals specially needed for munitions, and the recently enacted law for the regulation of explosives.

Plan to Fix Basis for Zinc Prices

Producers of zinc organized a committee Nov. 13 to co-operate with the War Industries Board in fixing a basis for establishing prices for the various grades of the product. The committee was formed following a consultation on Nov. 12 between the zinc men and Eugene Meyer, Jr., who has charge of purchases of non-ferrous metals for the government. The members are Edgar Palmer of the New Jersey Zinc Company, chairman; Charles T. Orr, Cornelius F. Kelly, C. M. Loeb, Sidney J. Jennings, N. Bruce McKelvie, Charles F. Baker, Walker W. Vick, R. A. Cowles, A. P. Cobb, E. W. Furst, S. M. Evans, J. D. Lang and S. S. Tuthill.

The committee is expected to hold frequent meetings until the necessary data for study by the War Industries Board have been gotten together. A method for establishing prices for zinc ore is also to be studied and recommended to the Washington authorities.

Annual Report of the Bureau of Mines of 1916

From advance sheets of the Yearbook of the Bureau of Mines—1916, we make the following pertinent excerpt:

Probably no year in the history of the United States showed greater progress in the mineral industries than 1916. Although this progress was undoubtedly stimulated by the war in Europe, which caused extremely high prices for some of the metals, yet the fact remains that mining is being regarded more as a business and less as a speculation, and the benefits of business methods are becoming evident. Practices that were almost universal a few years ago have been largely abolished, the mining public has been brought to recognize the folly of wasteful and dangerous methods, and there is a gratifying unanimity of opinion in regard to the conservation of life and health, as well as of our mineral resources. The people of the United States realize more fully than ever before the extent and value of the country's mineral resources and the possibilities that await intelligent and well-directed efforts at utilization.

In response to numerous requests for assistance in evolving suitable processes for treating the low-grade complex sulphide ores of the Silverton district, Col., the bureau undertook an investigation of these ores. Late in May, 1913, a junior geologist of the Bureau of Mines was sent to the Silverton district to conduct the investigation.

The bureau's representative has carefully studied the conditions in the district and has collected many samples of the various ores. From these samples polished sections were made for a metallographic study, which has already yielded much valuable information as to the composition and character of the ores and the reasons for the low recovery obtained by the concentrating methods used. The next step will be investigation to ascertain the proper means of concentration.

One of the most important and far-reaching lines of investigation being carried on by the Bureau of Mines pertains to the most efficient and economical methods of utilizing our fuel supplies and the various products derived from them.

Tests as to the production of gas from lignite have been made by several methods under a variety of conditions of temperature, time and other modifying factors. The lignites have been found to yield much gas, its quality and character varying, of course, with conditions of production. The power tests indicate that it can be successfully employed to drive gas engines and that in such Western lignite regions as are without water power, power can be produced at such a low figure as to exert a marked influence in the development of a variety of industries dependent upon a cheap and abundant power.

Study has also been given to the carbonization of lignite, with the subsequent production of briquets, ammonium sulphate, tar and oils.

Investigations in mineral technology covered the mining, concentration and treatment of carnotite ore for the recovery of radium, uranium and vanadium. In co-operation with the National Radium Institute, the bureau produced more than eight grams of radium. A considerable amount of work was done on the treatment of molybdenum ores and on the production of rare-metal alloys containing molybdenum, tungsten, uranium and vanadium.

The non-ferrous alloy investigations of the bureau have been conducted in co-operation with Cornell University. The problem concerns mainly the metal losses in the brass industry and the evolution of a suitable type of electric furnace for brass melting. The melting of aluminium chips and the production of ferro-uranium are other problems under investigation at Cornell.

A ceramic research has been conducted on the Kaolins of Georgia to see if some of our vast deposits of impure white clays could not be refined sufficiently to permit of substitution for foreign materials. The problem has been attacked with the methods of colloid chemistry.

Among petroleum investigations of importance are the methods of producing gasoline from the less valuable products of crude oil, and the extraction of oil from oil shales. Shale oil has never been produced in this country until recently, owing to our large oil reserves, but it will be only a very short time until the oil-shale industry will be one of magnitude.

The metallurgical investigations of the bureau have been extensive and cover corrosion of metals, fluidity of blast-furnace slags, brine-leaching of low-grade and complex ore containing lead, the application of the flotation process to ore slimes, production of zinc dust from solutions of zinc, sulphurous acid process for copper and zinc-lead ores, behavior of alluminium in cyanide solutions, efficiency of crushing machines, smelter fume investigations and sulphur recovery processes. The complete report of the bureau is an interesting review of progress.

Chemical Investigation of United States Tariff Commission

Section 501 of the Act of Congress, dated Sept. 8, 1916, provides for the taking of a special census of the production of intermediates, dyes, and other coal-tar products in the United States. The act provides: "If, at the expiration of five years from the date of the passage of this act, the President finds that there is not being manufactured or produced within the United States as much as 60 per centum in value of the domestic consumption" of intermediates and dyes, medicinals, and other finished products, "he shall by proclamation so declare, whereupon the special duties imposed by this section on such articles shall no longer be assessed, levied, or collected." *The President has requested the Tariff Commission to undertake the collection of information necessary for the exercise of this power.*

The commission is preparing for a systematic census of the production of all coal-tar products in a broad sense, including intermediates, dyes, medicinals, flavors, photographic chemicals and synthetic phenolic resins.

The Geological Survey has been for many years collecting statistics on the operation of coke-oven plants, including production of the by-products coal tar, benzol, toluol and naphthalene. Arrangement has been made whereby duplication of work will be avoided by co-operation between the Survey and the Tariff Commission. Under this arrangement the Survey will continue to collect all the information on the operation of coke-oven plants which it has been collecting in the past, and in addition it will (1) distinguish between crude and refined naphthalene, (2) make an inquiry in regard to the manufacture of any intermediates at coke-oven plants, (3) collect annually the statistics on the operations of gas houses, (4) ascertain and report to the Tariff Commission confidentially information in regard to the disposal of the materials, specified above, produced and sold by the coke ovens and gas plants. The Tariff Commission will not go directly to the coke plants or gas houses, but will secure statistics on the production of these plants from the Geological Survey.

The Tariff Commission will make a detailed inquiry in regard to the development within the United States of the complex chemical industries which convert these by-products of the coke ovens into finished dyes, medicinals, photographic chemicals, flavors, and synthetic phenolic resins. Over 150 firms are now engaged in the manufacture of these products within the United States.

The Tariff Commission will not make an independent inquiry in regard to the production of explosives in the United States, since other departments of the Government are following this closely. The commission, however, will ascertain the production of intermediates derived from coal tar and used in the making of explosives, such as diphenylamine used in the making of guncotton for stabilizing smokeless powder. These intermediates, which are specifically mentioned in the act, may be diverted to making dyes when the normal demand for explosives ceases.

The general investigation of the commission into the chemical industries is progressing. Conferences have been held with interested specialists and with heads of other bureaus collecting information of a similar or related character, factories have been visited by agents of the commission, the products affected have been classified, and information upon them is being compiled. A general questionnaire, designed to secure information in regard to the competitive conditions in the chemical industries, will be sent out. Special emphasis will be laid on the branches of the chemical industries which have shown the most revolutionary changes during the war.

Service Overseas for Chemists

The Chief of Ordnance, War Department, announces that chemists are wanted for early service overseas in the Enlisted Ordnance Corps, National Army. Men between the ages of 18 and 40, who wish to engage in this work, and consider themselves competent to serve, are urged to communicate at once with the Chief of Ordnance, War Department, Washington, D. C. There is a lot of work to be done and the army which has the best equipment and best men is the army that is going to win. Experts in various lines are badly needed, and chemists will find here an opportunity for patriotic service.

Mill Pumping Systems

By A. W. Allen

The selection of a suitable system for mill pumping involves consideration of several important factors. Owing to the varied conditions of work and the different characteristics of the fluids to be elevated, the principal requirement is suitability; *i.e.*, the system decided upon should involve minimum attention for control and repair, and must operate at a reasonable efficiency. Elevation of pulp and solution are phases of milling work in which continuity of operation is of primary importance, and for this reason every opportunity should be taken in the first instance to install a machine which will do the work without unnecessary attention, or demand an excessive loss of running time for repairs and renewals.

It is convenient to subdivide the apparatus more commonly used for this purpose into nine divisions, according to the class of material to be handled and the height to which it must be elevated. Table I shows

TABLE I—MILL PUMPING SYSTEMS

Material to be Pumped	Low Lift (to 25 Ft.)	Medium Lift (to 50 Ft.)	High Lift (to 100 Ft. or More)
Water or solution.	Air-lift Frenier pump Centrifugal pump	Centrifugal pump Compound air-lift	Plunger Pump (1, 2, or 3-throw) Compound centrifugal pump
Slime pulp.....	Air-lift Diaphragm pump Frenier pump	Compound air-lift Centrifugal pump	Plunger pump (1, 2, or 3-throw)
Sand pulp.....	Centrifugal pump Air-lift Frenier pump	Centrifugal pump Tailings wheel	Plunger pump (3-throw)

the applicability of eight classes of pumps for different kinds of work. A selection is usually made from among these.

Water or Solution

LOW LIFT

For this work it is usual to employ either the centrifugal, the air-lift, or the Frenier pump. In point of efficiency with good design, they may be considered in the order named. The operation of the air-lift or the Frenier pump insures an aëration of the water or solution. This is sometimes an advantage, sometimes a disadvantage. In the latter event the centrifugal will be chosen as the most suitable.

For compactness, and ability to drive by direct motor connection, the centrifugal will also be favored. For fairly efficient operation with a variable supply and with automatic control, the air-lift may be considered as superior to either of the other machines mentioned. Where compressed air is not available, the choice will lie between the centrifugal and the Frenier, with a probable decision in favor of the former on account of greater compactness, higher efficiency, and larger capacity.

For small-capacity, low-lift circulating work, a single-plunger pump or diaphragm pump is sometimes used, and arranged for variable stroke by means of an eccentric adjustment.

MEDIUM LIFT

For this work there is little to choose between the centrifugal and the compound air-lift, although the latter is generally chosen on account of greater compactness.

HIGH LIFT

For high-lift work, the compound centrifugal or the plunger pump is usually adopted. The greater comparative flexibility of the latter under varying conditions of speed and lift indicates a point of superiority over the centrifugal.

Multiple-throw plunger pumps are to be preferred, otherwise a heavy flywheel is advisable. A submerged suction saves time and trouble, especially in the case where an incrustation is liable to form on the valves, which results in the pump frequently losing its suction water.

Slime Pulp

LOW LIFT

The advantages of the air-lift for slime pulp elevation are too well known to need elaboration. At the present time, however, it is being largely superseded in low-lift work by a diaphragm pump with adjustable stroke. This latter adjustment has not yet been designed to operate automatically with a varying flow of pulp, as may be arranged with the air lift. The diaphragm pump is, however, particularly well suited for low-lift work, and its ability to counterbalance the difference between the static head of the average of the thin pulp in a tank and the thick pulp at the discharge without loss of fall has resulted in its wide adoption to handle the sludge from mechanical thickeners.

The application of the diaphragm pump as regards height of lift is exceedingly limited. Table II shows

TABLE II—APPROXIMATE THEORETICAL SUCTION AND DIAPHRAGM PUMP LIFTS (AT NORMAL TEMPERATURE)

Altitude	Specific Gravity of Fluid							
	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700
	Maximum Suction Lift in Feet							
Sea level	34	31	28	26	24	23	21	20
1,000 ft.	33	30	27	25	23	22	21	19
2,000 ft.	32	29	26	24	22	21	20	18
3,000 ft.	31	28	25	23	22	20	19	18
4,000 ft.	29	27	24	23	21	20	18	17
5,000 ft.	28	26	23	22	20	19	18	17
6,000 ft.	27	25	22	21	19	18	17	16
7,000 ft.	26	24	21	20	19	17	17	16
8,000 ft.	25	23	21	19	18	16	16	15
9,000 ft.	24	22	20	18	17	16	16	14
10,000 ft.	23	21	19	18	17	16	15	14

theoretical possible lifts, but owing to slow speed and entangled air in the pulp, and the difficulty in maintaining the vacuum under normal conditions, this class of pump usually operates at from 25 per cent to 50 per cent of these amounts.

Heating of pulp is sometimes a necessary phase in ore treatment. Its effect on diaphragm-pump operation may be estimated by reference to Table III.

Frenier pump-capacity data are given in Table IV. The fixed output from this type of pump is a disadvantage. It deals unsatisfactorily with an underload and cannot cope even temporarily with an overload. Height of lift is controlled by the diameter of the spiral, and no variation in normal speed (about 20 r.p.m.) can affect the result. Efficiency of operation demands that the pulp in the box be kept at a uniform level. To insure this it is often found advisable to oversupply

Table III—Effect of Temperature on Suction and Diaphragm Pump Lifts

Deg. Fahr.	Approximate Theoretical Suction Lift in Feet, for Water, at Sea Level
60	34
80	33
100	32
120	30
140	27
160	23
180	16
200	8

Table IV—Approximate Frenier Pump Capacities

Size, Inches	Specific Gravity of Fluid					
	1,000	1,100	1,200	1,300	1,400	1,500
	Tons per 24 Hours					
44x 6	45	49	54	58	63	67
48x 6	45	49	54	58	63	67
54x 6	45	49	54	58	63	67
44x 8	54	59	65	70	76	81
48x 8	54	59	65	70	76	81
54x 8	54	59	65	70	76	81
44x10	63	69	76	82	88	94
48x10	63	69	76	82	88	94
54x10	63	69	76	82	88	94

the pump and allow the surplus to be handled by an arrangement such as an auxiliary air-lift arranged for automatic operation.

All three types of pumps used for low-lift slime pulp elevation operate without the necessity for gland clearance water, and are, therefore, suitable in the case where any further dilution of the pulp is undesirable.

The use of centrifugal pumps for agitating the contents of large vats by low-lift pumping is of sporadic occurrence. The results are invariably the same. The fact that (1) actual agitation is confined to the comparatively small percentage of the pulp passing through the pump; (2) there is nothing to prevent settlement of the solids around the sides of the vat; and (3) that a continuous supply of diluent to the pump glands is needed, are sufficient reasons against the adoption of the scheme.

Low-lift slime pulp handling by centrifugal pumps is, however, a feature of decantation practice, and illustrates a method of utilizing to the full the characteristics of these machines. Ample dilution is desired, and thorough mixing is insured by the operation of the pump, which delivers at high capacity. Pulp transference may thus be made in the minimum of time and settlement commenced at the earliest possible moment. A 12-in. pump of this class will handle about 2000 tons of 4 to 1 slime pulp per hour; and if only natural or true slime constitutes the solid portion of the pulp, the wear on liners and runners is comparatively low.

HIGH LIFT

The multiple-type plunger pump is to be preferred, and ball valves are suitable. Arrangements must be made for a supply of clearance water under pressure to be delivered around the plunger and below the stuffing boxes, to prevent undue scouring of the plungers against the packing. The importance of clearance-water provision is such that it is advisable to operate the opening and closing of this service by direct connection with the belt strike or clutch operating the pump. Neglect of this precaution may result in considerable damage to the plungers and the necessity for the renewal of the packing.

The correct pressure of clearance water is best maintained by the provision of a small tank fitted with overflow, and placed above the level of the apparatus receiving the pump discharge, and at a height whch takes into consideration the weight of the material being handled.

Sand Pulp

LOW LIFT

In point of efficient operation the centrifugal probably claims first place for handling coarse sand in pulp for low lifts. Normal velocity for this machine is high when comparison is made with the air-lift or the Frenier pump. Hence the greater ability of the centrifugal to keep grains of sand in suspension until the discharge point is reached. The question of the suitability of either of the other class of pumps for this work will depend on the size and specific gravity of the grains of material comprising the solids in the pulp. If there is a tendency to settle quickly, then the centrifugal should be adopted. If pulp dilution with gland clearance water, essential to the operation of the centrifugal sand pump, must be avoided, then the matter is outside the purview of this article, and the installation of a belt-and-bucket or belt elevator should be considered.

MEDIUM LIFT

In spite of its wide adoption for this class of work the centrifugal has its disadvantages. Given an automatically-operated water service for gland clearance, which will certainly save the shaft if laid true, there is usually considerable trouble caused by the wear of liners and runners on account of the comparatively high speed necessary for effective operation. This wear causes erratic results long before it is necessary to hang up for repairs or renewals. If anything like continuity of operation is desired it is always advisable to erect in duplicate.

The tailing-wheel is ungainly in appearance, and could not be considered in the compact, covered-in mills where the winter is severe. In other localities, however, it has its good points, not the least of which is the fact that first cost is practically last cost. If well made in the first instance, it needs little attention, and practically no repair.

An additional point in favor of the tailing wheel is that although efficiency is not high (50 per cent to 60 per cent) it is certainly uniform under varying conditions of elevation and capacity, for which the details may be estimated with comparative facility. With a centrifugal, on the other hand, there must be a definite speed for each lift, and the runner must be carefully designed and correctly proportioned for the work it is called upon to do. When lifting above 25 ft. or so such pumps often exhibit an abnormal power consumption, which the average millman is at a loss to account for.

Comparative results of the operation of the tailing-wheel and centrifugal pump for medium lifts show a considerable economy in favor of the wheel, even when its high capital cost is taken into consideration. This is largely due to the lower efficiency of the centrifugal (40 per cent to 50 per cent) and the fact that the work

done for power expended decreases as the liners wear.

Sand pulp is often classified or screened after elevation. Apparatus for this purpose, without exception, will work more efficiently if given a steady feed. The pulsating flow from a centrifugal pump when the liners and runners are becoming worn is a feature against its adoption in the case where a uniform delivery is desired.

HIGH LIFT

Multiple-plunger pumps adopted for this purpose preferably should be arranged so that the suction is submerged. The supply tank may be equipped with a mechanical stirrer so that all the sand is kept in suspension. If an ordinary box is used for this purpose there is danger of the sand banking up on the sides. This usually leads to periodic slides of heavy material towards the suction, and invariably causes trouble. Particular care must be taken in the adequate provision of pressure clearance water, the same precautions being observed as with slime pulp.

The efficiency of the plunger pump increases with the lift; and for the high lifts required in ordinary mill work it usually averages about 70 per cent.

The necessity for the elevation of heavy sand in water for considerable vertical distances is luckily rare in most instances. Compound centrifugal pumps, or single-stage pumps worked in series, might be used; but the scouring action of the sand at high velocity represents much lost energy, causing unreasonable expense, and necessitating frequent attention for renewals. To obviate this trouble the pulp may be handled in a classifying dewaterer, the thin slime being pumped by either of the systems available and the wet sand elevated by means of a belt or belt-and-bucket elevator.

New York, N. Y.

The principal aluminum salts made in the United States, according to the U. S. Geological Survey, are alumina, alums, usually ammonium and sodium alums, aluminum sulphate, and aluminum chloride. Alumina is largely consumed in the manufacture of aluminum, and no figures of domestic production are available. Alums of various qualities are produced at 9 plants in the eastern United States, the total production of alum in 1916 being 27,257 short tons, valued at $1,177,881, an increase over 1915 of approximately 10 per cent in quantity and of 68 per cent in value.

Aluminum sulphate is made at 18 plants, 6 of which are located at municipal or industrial waterworks, which consume their entire output. The total quantity of aluminum sulphate produced in the United States in 1916 was 153,860 short tons, of which 6037 short tons did not enter the market but was used for water purification at the place of manufacture. The quantity of domestic aluminum sulphate which entered the market, 147,823 short tons, was less than the quantity in 1915 by 12 per cent, and the total domestic production fell off about 9 per cent. The value of the total production of aluminum sulphate in 1916 was $4,410,741, an increase of nearly 37 per cent over the value of the greater production of 1915.

Aluminum chloride is used for various purposes, among which may be mentioned the refining of mineral oils. This salt was produced at 5 plants in 1916, the total output being 3322 short tons.

The Physical Basis of Color-Technology

By M. Luckiesh

Physicist, Nela Research Laboratory

In the color industries the chemist has long been a mighty factor, but the physicist has not been generally accepted as being essential in this field. In fact, much of the physics of color is so little used in some of these activities that it is either not generally understood by those in charge of the technique, or its value is underrated. Spectral analyses, the quantitative determinations of the spectral characteristics of colored materials, provide the foundations for many important aspects of color-technology and without such data progress must be left to grope its way more or less blindly. With such data, and those derived from less analytical methods, many interesting facts and relations can be revealed and various factors can be studied which are unapproachable from the viewpoint of chemistry or from ordinary inspection. In delving into the physics of color many avenues of research in the development, manufacture and refinement of colored media suggest themselves. This entire subject cannot be covered adequately in a brief article, but perhaps an idea of the physical basis of color-technology may be gained from this presentation. An extensive treatment of apparatus, methods and data will be found elsewhere[1] and additional spectrophotometric data have been presented in a recent paper.[2]

THE RELATION OF THE ILLUMINANT

In dealing with colored media the illuminant is always a prominent factor, so it must be remembered that light and color are very closely related. In general, an illuminant consists of radiant energy of many different wave-lengths, a narrow range of which are capable of exciting the sensation of color. The energy of the shortest wave-length which is visible to the eye causes the sensation of violet and that of the longest wave-length which is visible excites the sensation of red. Between these two extremes the visible spectrum is found. The invisible radiant energy of short wave-length is called ultra-violet, and excites fluorescence, phosphorescence, chemical action, and many phenomena which are of interest to the color-technologist. The invisible energy of long wave-lengths is called infra-red and it possesses interesting relations to colored media.

The color of an object can hardly be considered as being inherent in the object because it depends upon the spectral characteristic of the illuminant. Any colored medium transmits (or reflects) radiant energy of an appreciable range of wave-lengths and, therefore, if the relative amounts of the energy of the various wave-lengths in this region differ for two illuminants, it should be obvious that in general the colored medium will appear different under the two illuminants. Furthermore, the reflection (or transmission) factor (sometimes called reflection coefficient) of a colored medium will not be constant but will depend upon the illuminant. These and many other points seem to be misunderstood, but it should be obvious that the illuminant should be considered as almost a part of a colored medium.

In Fig. 1 is shown a curve of the spectral reflection-

[1] Color and Its Applications, 1915, D. Van Nostrand Co.

[2] The Physical Basis of Color-Technology, Jour. Frank. Inst., 184, p. 73 and 227, 1917.

factors of ultramarine-blue pigment and also spectral luminosity curves of this pigment for three illuminants. The latter curves enclose equal areas and therefore represent the appearance of the spectrum of this pigment to the eye for equal total amounts of light reflected as explained later. From these an idea of the appearance of the color can be formed after some experience, or conversely, the reason for these different appearances under the three illuminants is manifest. It is seen that this pigment is of a purer color under skylight than under either of the other illuminants. The wave-lengths of maximum luminosity are 0.495μ and 0.54μ respectively for skylights and tungsten light. This wave-length of maximum luminosity is not necessarily the dominant hue of the color as analyzed by the eye or by the monochromatic colorimeter (discussed later), although these are often nearly coincident. Under the tungsten light the effect of the increasing reflection-factor toward the red end of the spectrum becomes evident. It will also be noted that this pigment becomes very ruddy in appearance under ordinary artificial light.

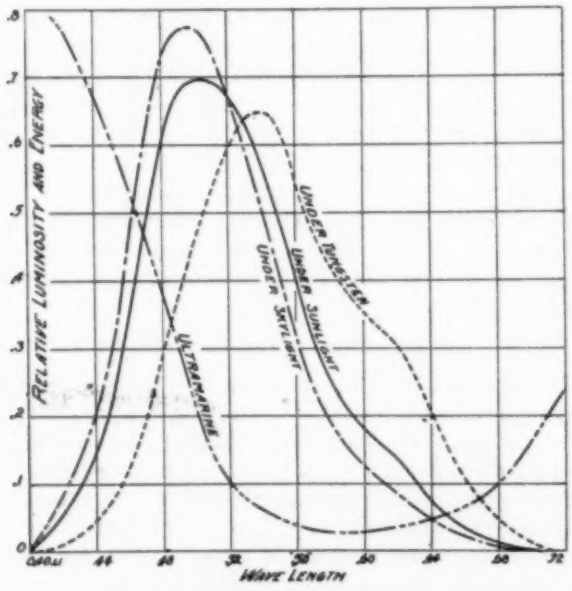

FIG. 1. INFLUENCE OF THE ILLUMINANT ON THE APPEARANCE OF ULTRAMARINE PIGMENT

THE ANALYSIS OF COLOR

Of the various methods of analyzing color, that of the spectrophotometer is the most analytical, and it provides data of far greater usefulness in the physics of color than the data which are yielded by any of the other methods. By this method the reflection (or transmission) factors of the coloring media are determined for radiant energy of all wave-lengths in the visible spectrum. When these are plotted we have the spectral reflection (or transmission) curves for the visible spectrum. By the same method the spectral character of an illuminant may be obtained. By multiplying the relative energy-values of the various wave-lengths of any illuminant by the corresponding visibilities of radiation, the spectral luminosity distribution curves are obtained for the given illuminant. These latter will vary with the illuminant and are often of greater importance than the spectral energy-distribution curves from a visual viewpoint. It is obvious that by multiplying corresponding spectral values the spectral energy-distribution and luminosity distribution curves of any colored medium may be readily obtained for any illuminant.

A number of curves are shown in Fig. 2 which illustrate spectral characteristics of illuminants and colored media and their uses. These are as follows:

I = spectral distribution of energy in the radiation from a Mazda B (vacuum) lamp, operating at 7.9 lumens per watt.

L_i = spectral luminosity-curve of this illuminant. This is found for each wave-length by multiplying the energy value by the visibility of radiation of that wave-length. The visibility of radiation of various wave-lengths has not yet been standardized, but some of the data available, curve V, are satisfactory for many practical purposes.

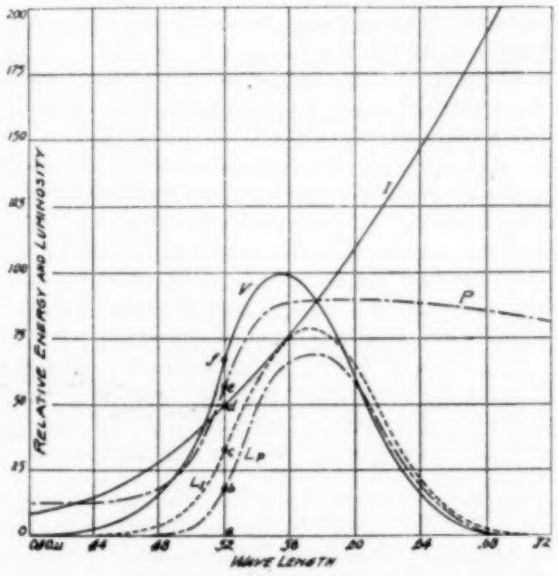

FIG. 2. A STUDY OF A PIGMENT (LIGHT CHROME YELLOW)

P = spectral reflection-factor curve of light chrome-yellow pigment. If the medium were transparent the spectral transmission-factor curve would have been used.

L_p = spectral luminosity curve of the pigment for this illuminant, I. This is obtained by multiplying the ordinates of curve L_i by the corresponding ordinates of curve P.

It should be noted that for most purposes only relative values are necessary but there should be no difficulty in distinguishing between relative and absolute values.

In order to make the procedure clear let us consider wave-length 0.52μ. At this point the relative amount of energy of this wave-length in the illuminant under consideration is indicated by *ad*. The visibility of radiation is indicated by *af*. Multiplying *ad* by *af* gives *ac*, or the relative luminosity of the energy of this wave-length in the illuminant. The reflection-factor of the pigment for energy of this wave-length is indicated by *ae*. Multiplying *ae* by *ac* gives the relative luminosity of the energy of this wave-length reflected by the pigment when illuminated by this particular illuminant. On integrating curves L_i and L_p the relative total luminosities are obtained and by dividing the area L_p

by L_i the reflection-factor of the pigment for this illuminant is obtained. For this particular case the latter value is 82 per cent.

This account has been given in detail in order to illustrate the data which are involved in such an analysis and to illustrate their relations.

The monochromatic colorimeter, which yields data in terms of hue, saturation, and brightness or luminosity, is the most generally analytical among the so-called colorimetric methods. This method analyzes color from the subjective viewpoint and yields data which may be readily visualized by one possessing some experience and an acquaintance with the spectral hues. From a subjective viewpoint the monochromatic colorimeter appears the most feasible method upon which to base a scientific nomenclature of color—an urgent need at present. An advantage of this method lies in relating the analyses to the constant and reproducible visible spectrum; however, in determining the saturation (unity minus the per cent white) a white light is necessary, and this has not been standardized. A further difficulty lies in the unsettled state of color-photometry, which is necessarily involved in determining the luminosity or refraction and transmission factors.

As analyzed by this method, a chrome-yellow might be expressed as having a dominant hue, 0.583μ; a saturation of 75 per cent, or 25 per cent white, and a reflection-factor of 82 per cent.

The trichromatic colorimeter yields analyses in terms of three more or less arbitrarily chosen primary colors; namely, red, green and blue. This is based on a well-known fact of color-mixture; i.e., that any color may be matched in hue by a proper mixture of these three properly chosen primaries. Young built what has later become known as the Young-Helmholz theory of color-vision chiefly upon facts of mixture of these three primaries. This method is not very analytical, and it is quite difficult to visualize a color from an analysis by this method. Furthermore, the data are often misleading to those not thoroughly familiar with their limitations, because the comparisons are made from the subjective standpoint. As an example of the character of the data yielded by this method the colorimeter readings for a chrome-yellow might be: red, 58; green, 37; blue, 5, as compared to a white standard for which the colorimeter readings were 33.3 for the three components.

Besides these chief methods, there are many kinds of colorimeters devised for special purposes—useful in their places, but yielding data of little general value analytically. Some of these are merely tintometers, consisting of a series of tints of various gradients in hue, saturation and reflection (or transmission) factors, designed chiefly for special purposes, such as confining a given product within certain limits as judged by color.

Of the various methods of color-analysis the spectrophotometer is not only the most analytical but its results are definite because standards required are readily available. The lack of standardization of a "white" light and the unsettled state of color-photometry mitigate against the usefulness of the data obtained by the monochromatic and trichromatic colorimeters. There is a need for much standardization in the terminology, notation and analysis of color. However, in color-technology these various methods can be widely applied at present with valuable results.

COLORED MEDIA

For the purpose of this article three classes of colored media will be represented and discussed; namely, pigments, dyes and vitrifiable colors or colored glasses. Pigments are distinguished from dyes by their insolubility in their vehicle, while dyes are soluble. This distinction may appear arbitrary, especially in some cases; however, it is employed to some extent and is a convenient classification. Pigments may be distinguished from paints in that the latter are pigments in a vehicle or medium. Vitrifiable colors are those which impart color to glass and to similar substances. Among pigments are found two general classes: one in which each particle is homogeneous, and the other in which a colorless base has been colored by depositing coloring matter upon it. Colored media vary in many physical characteristics, such as opacity, fineness and refractive index, and they may be considered as varying in "coloring power." However, these facts are of interest only incidentally in this article.

The color of a pigment in a finely divided state, whether the particles are separated by air or by a vehicle, is due to innumerable selective reflections from, and transmissions through, the minute particles. If the powdered pigment is given a smooth surface by pressure it does not appear as pure in color as when it is loosely packed, because in the latter case a greater proportion of the incident radiant energy is able to penetrate more deeply into the body and becomes colored by selective reflections and transmissions. Radiant energy is regularly reflected from even the small surfaces of the particles of pigment, and in those cases where the minute areas of surface are properly oriented this regularly reflected light does not find its way farther into the pigment, but is reflected practically unaltered in spectral character as compared to that energy which penetrates farther into the mass. Thus there is always reflected from pigments some radiant energy which is practically unchanged in spectral character, which accounts partly for the general lack of purity of the colors of pigments. It is seen that the character of the surface is important. Furthermore, the refractive indices of the pigment and of the vehicle (air in the case of dry powders) are of importance, because the amount of light regularly reflected from a surface is dependent upon these refractive indices. A careful study of the influence of the vehicle upon the color of a paint should lead to interesting data from this viewpoint alone. Work has been done in physical optics which is of extreme interest in this connection, but a discussion of it will not be presented here.

Although careful observation will reveal the influence of the porosity of a pigment surface upon its color, an excellent example for the purpose of illustration here is the color of a white cotton fabric compared with that of a white silk fabric after both have been soaked in the same dye solution. Silks are more transparent than cotton fibers; in fact, cotton fibers are merely translucent as compared with the transparency of silk fibers. The latter permit the radiant energy to penetrate more deeply, in general, than the cotton fibers; in other words, the cotton fibres by diffuse reflection turn the

energy backward before it has penetrated very deeply. For this reason the silk fabric appears of a purer color compared with that of the cotton fabric dyed in the same solution, the result, in the case of the silk, being similar to that which would have been obtained with the cotton if the latter had been dyed in a more concentrated solution of the dye.

In a manner similar to the case of pigments the solvent appears to have certain influences upon the color of a solution of a dye, although this subject has not been thoroughly studied. The substance upon which a dye has been deposited by immersion is also of importance in spectral analysis, as is indicated by the case of dyeing cotton and silk fibres. The spectral transmission factor of a dye-solution is a simple logarithmic function of the depth of a given solution or of its concentration, but this relation varies with the wave-length, in general in no definite relation between wave-length and spectral transmission-factor. For this reason no simple relation between total transmission and depth or concentration can be established. Such values of total transmission must be determined by direct measurement or by integration, as already discussed.

Colored glasses can be treated much in the same manner as dye-solutions. A given concentration of coloring material in a glass (that is, a given colored glass) apparently obeys the same law relating to thickness and transmission factor for a given wave-length as a dye-solution. However, it is not established that the introduction of various amounts of the coloring material (generally metallic oxides) results in corresponding concentration, as would be true in the case of dyes. In glass there is more or less chemical action, and the uncertain conditions of melting make this point difficult to decide.

The physics of the process by which glasses are colored by means of metallic compounds is not wholly clear. There are many chemical analogies which are of interest for their parallelism to the colors imparted to glasses by the metals in different states, but the reasons for the appearance of the colors cannot be considered as being thoroughly established. Garnett[3] has presented a very interesting discussion of the colors exhibited by certain glasses in which metallic oxides had been incorporated. It is a common supposition that the colors of certain glasses, such as gold red glasses, are due to the presence of very minute particles of metal. Solutions of some metals exhibit colors which are often exhibited by colored glasses in which the same metals have been introduced. Siedentopf and Szigmondy, by powerfully illuminating specimens of colored glass and colored colloidal solutions of metals obliquely, or at right-angles to the line of sight, were able to detect the presence of the metallic particles. Garnett's work explained some of their observations.

It is commonly considered that metals color glass in two ways: one by being in a state of true solution in the glass, and in the other, by being in a colloidal state. An example of the former is copper blue-green glass, and of the latter, gold red glass.

In dealing with the physics of colored media from the viewpoint of the physicist one cannot avoid the conclusion that there is a wide application of physics to color-technology in many directions quite unexplored; however, such a discussion would be beyond the scope of this article.

PIGMENTS

In Figs. 3 and 4 are shown the spectral reflection-factors of a number of dry powdered pigments.[4] In each case the dry pigment was gently pressed with a plate of glass and the relative amounts of radiation (or light) of various wave-lengths reflected from the thick layer was determined by means of a spectrophotometer. For the sake of simplicity, a surface of a pure white pigment may be used as a comparison standard if its reflection-factors for energy (or light) of various wave-lengths are known. Commercial whites and blacks are not generally strictly neutral pigments, but their selective reflection is difficult to measure except with highly refined apparatus. It is seen from Figs. 3 and 4 that pigments are far from being of high purity as colors. There are so many characteristics of pigments dependent upon simple though intricately interwoven physical phenomena that it is quite beyond the scope of this article to enter into such a discussion.

The direct measurement of the reflection-factor of colored pigments for a given illuminant is uncertain owing to the uncertainties of colorphotometry. Furthermore, owing to the different characteristics of sur-

[3] Phil. Trans. of Roy. Soc., A. vol. 203, p. 385.

[4] Kindly furnished by Sherwin-Williams Co.

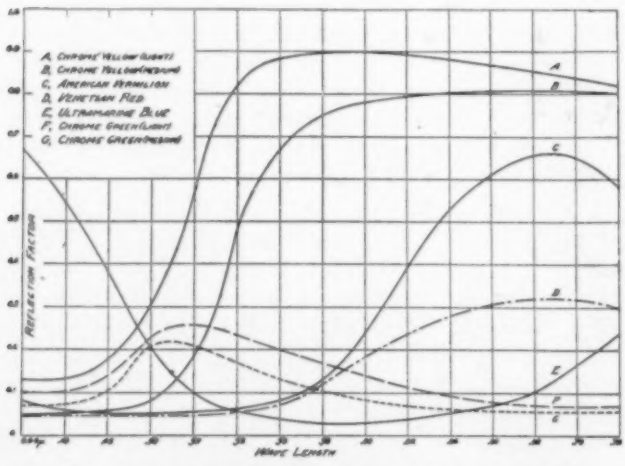

FIG. 3. SPECTRAL REFLECTION-FACTORS OF PIGMENTS

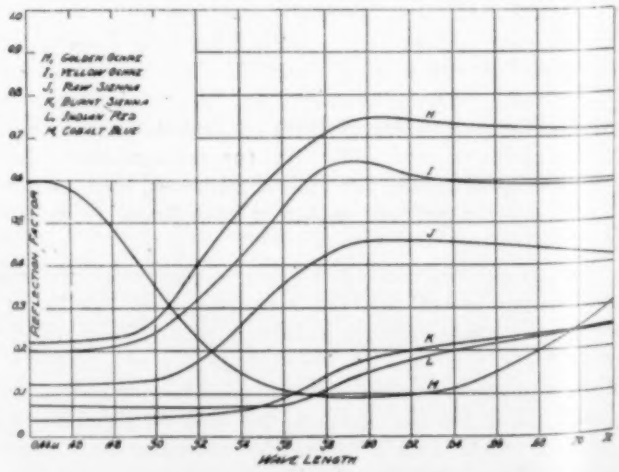

FIG. 4. SPECTRAL REFLECTION-FACTORS OF PIGMENTS

faces, such as dull and varnished, different conditions of illumination and measurement yield different results.[3] Owing to these uncertainties it is recommended that the procedure outlined in the discussion of Fig. 2 be adopted. By this method the reflection-factors for these pigments were determined for several illuminants, the details having been fully described elsewhere (2). In table I are given the reflection-factors for noon sunlight and Mazda B light (7.9 lumens per watt).

TABLE I

	Noon Sunlight	Mazda B
American vermilion	0.14	0.12
Venetian red	.11	.13
Tuscan red	.11	.12
Indian red	.10	.11
Burnt sienna	.11	.13
Raw sienna	.33	.37
Golden ochre	.58	.63
Chrome yellow ochre	.33	.40
Yellow ochre	.49	.53
Chrome yellow (medium)	.55	.63
Chrome yellow (light)	.77	.82
Chrome green (light)	.19	.17
Chrome green (medium)	.14	.12
Cobalt blue	.16	.13
Ultramarine blue	.07	.06
Magnesium oxide	.88	.88
Barium sulphate	.85	.85
Lamp black	.04	.04

Spectral analyses in the ultra-violet and infra-red regions are often of interest in general color-technology. In the former case spectrophotography is the simplest method of attack, although the procedure is a tedious one if high accuracy is desired. It is necessary to establish photographic-density and pigment-illumination (or exposure) relations for various wave-lengths in order to obtain the reflection-factors for radiant energy of various wave-lengths. Besides this, the ordinary precautions of photographic procedure must be taken. Another possible method is that which involves the use of the photo-electric cell. It is well to recognize the importance of such analyses in cases involving ultra-violet light. An excellent example is zinc white, which absorbs ultra-violet energy quite freely.

The investigation of the infra-red region requires a more elaborate apparatus, although in many cases where total energy-absorption is of interest this can be obtained rather easily by means of the thermopile or bolometer. In fact, the ordinary radiometer, or even the thermometer covered with a pigment, yields data which have some uses in practice. Coblentz[4] has published interesting data on the reflection-factors of various substances for infra-red and visible radiation of several wave-lengths. Among the substances which he studied were a number of pigments. The reflection factors of white pigments for energy of wave-length 4.4μ varied from about 0.1 to 0.4, and at 8.8μ and 24μ were considerably lower. These data especially emphasize the localized nature of absorption bands, as, for example, cobalt oxide is a better reflector of long-wave energy than zinc oxide, yet for visible rays it possesses a much lower reflection-factor than zinc oxide. Lead oxide is a much more efficient reflector of long-wave energy than zinc oxide, magnesium carbonate and other white pigments. The importance of the infra-red analyses is apparent in many practical activities. Coblentz has pointed out that a pigment which has a low reflection-factor for energy of wave-lengths in the region of 8μ to 9μ is a better house paint in hot climes, because it reradiates maximally in this region where the maximum radiation from bodies of temperatures from 20 deg. to 25 deg. C. is found. If the paint has a high reflection-factor for visible rays it thus minimizes the heating effect of the incident energy. Such a combination is quite desirable in minimizing the heating effect of solar rays. This is merely one example of a vast number of interesting problems which could be met with more intelligence if spectral analyses were available. There are many aspects such as fading, the effect of the vehicle, the development of paints by mixture, and even the chemistry of pigments in which spectral analyses systematically applied would be of great value.

[3] M. Luckiesh, Electrical World, May 19, 1917.
[4] Bulletin Bureau of Standards, vol. 9, p. 283.

DYES

The mixture of dyes is governed by the same subtractive principles of color-mixture as the mixture of pigments, although the greater number of dyes and the more exacting or delicate applications of dyes in industries, in the making of accurate filters, etc., make their special analyses of perhaps more importance than in the case of pigments. Certainly a knowledge of the spectral characteristics of dyes, as in the case of pigments, makes for an ease and certainty in making and in visualizing mixtures which cannot be enjoyed without such data. A more extended discussion of the usefulness of spectral analyses of dyes has been presented in the more extended paper.[2] There is a vast variety of dyes available, but many are so variable in character that spectral analyses may be only applicable to the particular specimens for which they were obtained. The vast variety of dyes and the sharpness of their absorption bands make it possible to obtain purer and brighter colors from this class of media than from others; however, there are some deplorable aspects such as the rarity of fairly pure blues and violets. Many so-called red dyes transmit deep violet light. There are satisfactory yellows for many purposes, but no yellow dye known to the writer transmits only a narrow spectral region. All of them transmit some green, yellow, orange and red in varying amounts, depending on the concentration of the solution. Among the greens are many dichroics; that is, it is common to find them transmitting deep red light. However, there are excellent yellowish green dyes of fair purity.

By combining various dyes almost any degree of purity of color can be obtained. For example, eosine exhibits a sharp absorption in the yellow region of the spectrum. By combining with this a yellowish green with a sharp cut-off in the orange region, a fairly satisfactory yellow may be obtained. Ethyl violet transmits deep red and deep violet so if it is mixed with an orange such as chrysoidin or a fairly concentrated solution of eosin a deep red is obtained. Similarly, a deep violet may be obtained by mixing a blue-green (which transmits no deep red) with ethyl violet. Of course, the chemistry of the mixtures must be borne in mind, but such mixtures can be made so directly and with predetermined results as to render spectral analyses invaluable. The subtractive principles of color-mixture are applied to the spectral curves in order to predetermine the results.

It has seemed that the aspect of fading could be studied by combining chemical knowledge with the spectral analyses of the dye before and after fading. This

aspect and many others might be more successfully invaded by means of such data. In the testing of the permanency of dyes the spectral characteristic of the illuminant is also of importance, although this is overlooked in most of such work. For example, an illuminant may contain considerable quantities of ultraviolet energy of very short wave-length which may be very destructive although the same rays may never be encountered in practice.

APPLICATIONS OF SPECTRAL ANALYSES OF DYES

The uses for spectral analyses of dyes are manifold, as in the case of any class of colored media. In general they provide a physical basis for systematic color-mixture, besides providing the necessary information for choosing dyes for many purposes. In many aspects of color-technology only the integral or subjective color is finally of interest, but the author cannot refrain from emphasizing that even in such cases an intimate knowledge of colored media and their mixtures cannot be attained without spectral analyses, and that the combination of dyes becomes systematic with such data available.

With spectrophotometric apparatus well maintained, a complete spectral analysis can be made in about an hour, although there is much room for improvement in such apparatus which will result in the saving of time. However, this is not a serious matter, because for a given coloring material only one analysis need be made, as will be shown later, to provide information for all degrees of concentration or depth of solution. The author has available hundreds of spectral analyses which, after once obtained, are a perpetual source of information.

LAWS

In order to simplify the study of coloring media, especially dyes and colored glasses, several simplifications have been made. These are based on theory and have been confirmed by experiment on a few typical specimens. In order to develop this procedure it is necessary to revert to some of the established laws. Lambert first stated that all layers of equal thickness of a transparent medium absorb equal fractions of the radiant energy which enters them. This is true for homogeneous or monochromatic radiation, but cannot be applied to the total absorption of radiant energy of many wave-lengths or of extended spectral character. It follows from Lambert's law that if the thickness of the absorbing medium increases in arithmetical progression the radiation transmitted should decrease in geometrical progression.

It can be proved that,

$$J = J_o e - kd$$

where J_o is the original intensity, J the intensity after traversing a thickness d, and k is a constant depending upon the substance and upon the wave-length of the radiant energy. Various terms have been applied to this factor, for example, absorption-coefficient. In logarithmic form this equation is expressed as:

$$Log \frac{J}{J_o} = log\ T\lambda = -k\lambda\ d\ log\ e = -\Sigma\lambda\ d$$

where $T\lambda$ is the transmission factor for energy of wave-length λ, and the subscripts, λ, indicate the factors which vary with the wave-length. Beer deduced the law that the absorption is the same function of the concentration of a dispersing absorbing substance as of the thickness of a single substance, which may be expressed thus:

$$J = J_o A\lambda^{cd} \text{ or } T\lambda = A\lambda^{cd} \text{ or } log\ T\lambda = cd\ log\ A_\lambda$$

where c is the concentration, A is the transmission coefficient or transmissivity, and the other symbols represent the same factors as in the foregoing equations. The validity of Beer's law has been questioned by some, and it appears that there is some doubt as to its validity in such cases as colloidal solutions. This law appears to hold when the absorbing power of a molecule is uninfluenced by the proximity of other molecules. Obviously, if any change takes place in the condition of the dispersed substance on altering the concentration the law will not hold. Incidentally there is work to be done on the validity of this law in the cases of "colloidal" glasses. Lambert's law appears to be firmly established.

In so far as the foregoing laws are valid (and it appears that this is true for all practical purposes such as described in this article), for a given solution log $T\lambda$ is proportional to d, and for a given depth, or containing cell, log $T\lambda$ is proportional to c. By the use of co-ordinate paper having a logarithmic scale along one axis and a uniform scale along the other a great deal of interesting data can be obtained from one spectral analysis.

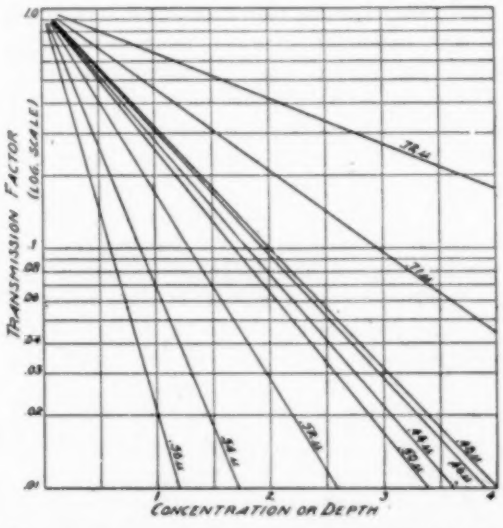

FIG. 5. RELATION BETWEEN SPECTRAL TRANSMISSION-FACTOR AND DEPTH OR CONCENTRATION OF A SOLUTION OF METHYLENGRÜN

By means of the foregoing mathematical relations the spectral analyses of colored solutions (and colored glasses) of any thickness and concentration can be obtained from two determinations of spectral character, which often may be reduced in actual practice to a single determination. Such a method has been found exceedingly practicable in preliminary reconnoitering in search of combinations of dyes for filters, in the development of colored glasses, and in the study of many problems arising in color-technology.

Assume a solution of methylengrün of either known or unknown concentration. A cell of a known thickness is filled with the solution and a spectral analysis is made. For such a purpose a fairly low concentration or small depth is chosen, so that radiations of all wave-lengths which are of interest are appreciably trans-

mitted. On logarithmic paper, as previously described, a plot is made, as shown in Fig. 5, the transmission factors[1] from the spectral analysis being plotted on the logarithmic scale vertically above the arbitrarily selected point on the abscissa axis in this case taken as unity. The abscissæ scale may represent either concentration or depth and may be either a relative or an absolute scale. Straight lines are drawn through the points to a common point on the ordinate axis representing complete transparency or unity on this logarithmic scale. This is the common point if corrections have been made for surface reflections in the cell or from the glass surfaces in the case of a colored glass. If these corrections have not been made, the common point usually will be near 0.92 on the "transmission axis" if two surface reflections must be accounted for. Each straight line represents the relation of log $T\lambda$ and depth or concentration for a certain wave-length. By extending these lines the spectral characteristic of any depth or concentration may be read from the corresponding vertical line. If the original spectral analysis has been made with care, such a simple plot yields a vast amount of data.

Dichromatism.—Methylengrün has been chosen in Fig. 5 because it also illustrates the interesting case of dichromatism so commonly exhibited by dyes. It is seen that the slope of the line for 0.72μ is less than any of the others. This is proof that the dye is adichroic. Some lines are very steep, which indicates a large value of the absorption-coefficient for radiation of these wave-lengths. From the plot it is seen that this dye, in solutions of high concentration or of great depth, will not be green, but will be red.

Similar graphical analyses may be made with relative spectral luminosity values, instead of spectral energy values, but these will not be discussed here. In the former paper (2) the entire relation between transmission factor, wave-length, concentration and depth of solution has been illustrated and discussed.

SPECTRAL ANALYSES OF GLASSES

As in the case of dyes, spectral analyses of colored glasses have many uses in practical developments. Owing to greater difficulties in making mixtures of coloring media in glasses such data are even more welcome in the development of colored glasses. By means of such data these coloring elements can be mixed computationally to obtain the desired spectral characteristic. From very meagre data on the chemical composition from one melt fairly definite strides toward realization may be made in succeeding melts. Of course, there are chemical considerations which sometimes alter the predictions based on computation; however, such a procedure forms a most definite working basis. In the combination of glasses for special filters, lighting effects, etc., the computational method often saves time and provides definite data. Sometimes only the subjective color is desired, but even in these cases spectral analyses of elemental colorings provide the basis for manipulating the available vitrifiable colored media in a manner analogous to the combination of pigments.

In the manufacture of colored glass there is a limited number of coloring materials available, and when the glass must be limited to one general composition, such as soda lime, for example, the colors which are possible of attainment are further limited. However, by combining various coloring materials the variety of colored glasses can be enormously extended to meet the requirements of science and art.

It is beyond the scope of this article to present spectral analyses of glasses, but these may be found in references given and elsewhere, but the importance of such data cannot be overemphasized.

USES OF SPECTRAL ANALYSES OF GLASSES

The applications for spectral analyses of colored glasses have been fairly well covered in the discussions of pigments and dyes, for the same general procedures can be applied to colored glasses. The concentration is not so definite as in the case of dyes, because, owing to the high temperature at which glass melts and to chemical action, the concentration of coloring material in the final glass cannot always be predicted from the amount of the coloring metal added to the mix. Some of the metals, such as cobalt and copper, under standardized conditions of melting, appear to produce concentrations of coloring material proportional to the amounts of the oxides added to the mix, but in some cases there is doubt as to this proportionality. There is need for systematic study in this direction. In the case of the red glasses, for example, gold ruby, which in ordinary manufacture assumes its red color on reheating, the manipulation has considerable effect upon the density of the color. After a colored glass has been obtained it is possible to procure from a single spectral analysis the integral transmission factor for any illuminant, the spectral characteristics of other thicknesses, and those of combinations of these thicknesses with other colored glasses as already outlined.

In developing a colored glass for a specific purpose various factors are considered, such as the illuminant to be used and the result to be obtained. From these an ideal spectral transmission curve is determined, and by means of a few spectral analyses of different colored glasses, bearing in mind the chemical considerations if a mixture is finally necessary, various combinations can be made with the aid of the graphical method.

Often the ultra-violet and infra-red spectral transmissions are of interest, and these are made in the manner already described. The data on a coloring element are not considered to be sufficiently complete for record if the ultra-violet transmission is not studied at least qualitatively, and in some cases the infra-red transmission is investigated.

National Lamp Works of General Electric Company,
Nela Park, Cleveland, Ohio.

[1] Note.—Transmission factor is defined by the Illuminating Engineering Society as the ratio of the transmitted to the incident flux. In the present use the surface reflections are eliminated in order to make the data more useful, so that the same definition applies here for the given thickness if the body is assumed to be immersed in medium of the same refractive index.

The market for bauxite in the United States is east of Mississippi River, and the largest consumers are located at or near the following cities: East St. Louis and Aurora, Ill.; Detroit, Mich.; Cincinnati, Ohio; Knoxville, Tenn.; Philadelphia and Erie, Pa.; Niagara Falls and New York City, N. Y.; and Boston, Mass. Recently a number of municipal and industrial waterworks have installed small plants for the manufacture of aluminum sulphate for use in purification of water. It is not believed that this new market will materially affect the industry, as it seems probable that its demands will not be great.

Bibliography of the Manufacture of Ferro-Manganese

By E. C. Buck

1877—DEBY, J.
Report on the progress of the iron and steel industries in foreign countries.
The manufacture of ferro-manganese.
J. Iron & Steel Inst., 1877, pp. 284-89.

RILEY, ED.
On the estimation of manganese in spiegeleisen, and of manganese and iron in manganiferous iron ores.
J. Iron & Steel Inst., 1877, pp. 52-107.

1880—SCHLINK, J.
On pig-iron making in Germany.
Report on the manufacture of ferro-manganese in the blast furnace.
J. Iron & Steel Inst., 1880, No. 2, pp. 532-33.

1881—LEDEBUR, A.
On the theory of manganese blast furnaces.
Glaser's Annalen für Gewerbe und Bauwesen, 1881, June 1, vol. 8, No. 95, pp. 450-54.

1885—POURCEL, A.
Ferro-manganese.
Génie Civil, 1885, vol. 7, No. 1, 2 and 4, pp. 3-4, 21-23, 50-52.
Stahl u. Eisen, 1885, Sept., vol. 5, No. 9, pp. 475-89.
Eng. & Min. Jour., 1885, vol. 40, pp. 353-54.
Abst., J. Iron & Steel Inst., 1885, p. 251.

1886—SANDAHL, C. J.; BARGATE, G., and PHILLIPS, C. B.
Manufacture of ferro-manganese, silico-spiegel, spiegeleisen and chrome iron.
British Pat. 6977, May 25, 1886.
Abst., J. Soc. Chem. Ind., 1887, vol. 6, p. 511.

STONE, G. C.
The manufacture of spiegeleisen from Franklinite residuum.
Engng. Min. Jour., 1886, vol. 41, pp. 208-209, 229-30, 247.
Abst., J. Iron & Steel Inst., 1886, No. 1, pp. 299-302.

1888—HOLGATE, T. E.
The composition of ferro-manganese and ferro-silicon made in the blast furnace.
Proc. South Staffordshire Inst. Iron & Steel Works Managers, 1888, Dec. 15, pp. 23-43.

MEISSNER, C. A.
Loss of manganese, etc., in melting and remelting.
Iron Age, 1888, vol. 41, p. 998.
J. Iron & Steel Inst., 1888-II, pp. 249-50.

1889—GAUTIER, FERD.
Ferro-metallic alloys. Their manufacture. Properties. Uses.
Bulletin de la Société de l'Industrie Minérale, 1889, vol. 3-II, pp. 851-800.
Chapter on: Ferro-manganese.

KERN, S.
Ferro-manganese with a low percentage of carbon.
Chem. News, 1889, Feb. 15, vol. 59, p. 75.

1890—ANONYMOUS.
Remarks on the blast-furnace method for the manufacture of ferro-manganese at the Sava and Jauerburg Works, Upper Caruiola.
Stahl u. Eisen, 1890, vol. 10, pp. 422-23.

GOUVY, A.
The alloys of iron: Ferro-manganese.
Stahl u. Eisen, 1890, April, vol. 10, pp. 321-23.

WEDDING, DR. H.
The progress realized in the metallurgy of iron in Germany since 1876, with particular reference to the basic process.
Stahl u. Eisen, 1890, Nov., vol. 10, p. 936.
Manufacture of ferro-manganese at Oberhausen.

WEEKS, J. D., and STONE, G. L.
The manufacture of spiegeleisen and ferro-manganese.
Report of the Mineral Industries in the United States at the 11th Census, 1890, pp. 323-29.
Abst., J. Iron & Steel Inst., 1893, No. 1, pp. 300-01.

1891—KEEP, W. J.
Manganese in cast iron.
Trans. Amer. Inst. Min. Engrs., 1891, vol. 20, pp. 291-316.

RATHKE, B.
Crystalline ferro-manganese.
Liebig's Annalen, 1891, vol. 260, pp. 326-337.

1892—DURRE, E. F.
Die Anlage und der Betrieb der Eisenhütten.
Ausführliche Zusammenstellung neuerer und bewährter Construktionen aus dem Bereiche der gesamten Eisen- und Stahl-Fabrikation.
1892, vol. II, pp. 298-99: Ferro-alloys manufactured in the blast furnace; pp. 311-17: Composition of blast furnace charges for the manufacture of spiegeleisen and ferro-manganese.

GARRISON, F. L.
The Green-Wahl process for manufacturing manganese and alloys of manganese free from carbon.
Trans. Amer. Inst. Min. Engrs., 1892-93, vol. 21, pp. 887-906.

HOGG, T. W.
Triple alloys of iron, manganese and aluminium.
Chem. News, 1892, vol. 66, p. 140.
J. Iron & Steel Inst., 1892-II, pp. 508-09.

1893—HAMPE, W.
On the unequal distribution of manganese in ferro-manganese.
Chem. Ztg., 1893, vol. ?, p. 99.
Stahl u. Eisen, 1893, vol. 13, p. 392.

JORDAN, S.
Volatility of manganese.
Compt.-Rendus, 1893, vol. 116, pp. 752-53.
Abst., J. Soc. Chem. Ind., 1893, vol. 12, p. 764.

LORENZ, R., and HENSELER, F.
On the volatilization of manganese at high temperatures.
Z. anorg. Chem., 1893, vol. III, pp. 225-29.

MOISSAN, H.
The reduction of nickel, chromium and manganese at high temperature.
Compt.-Rendus, 1893, vol. 116, pp. 349-51.

1895—HEIBLING, J., Grenoble (France).
Improvements in the electrolytic manufacture of ferro-manganese, ferro-chrome, ferro-aluminium, ferro-nickel and other alloys having an iron base (carbon and lime flux).
British Pat. 18487, Oct. 3, 1895.
Abst., J. Soc. Chem. Ind., 1896, vol. 15, pp. 726-27.

UNDEN, G.
Spiegeleisen manufactured at the Cambria Iron Works, Johnstown, Penn.
Jernkontorets Annaler, 1895, vol. 49, p. 117.
Abst., J. Iron & Steel Inst., 1895-II, vol. 48, p. 480.

1897—ASCHERMANN, H. CASSEL.
Process for the extraction of metallic alloys (ferro-manganese, etc.) and pure metals by electric heat (sulphide of antimony flux).
British Pat. 859, Jan. 12, 1897.
Abst., J. Soc. Chem. Ind., 1897, vol. 16, pp. 446-47.

1898—HAGES, LEON.
Traité de Métallurgie du Fer.
Tome premier: Elaboration des Métaux.
Paris, Librairie Générale Scient. et Industrielle H. Desforges, 1898, pp. 108-115: Ferromanganese; its manufacture.

1899—ZEIDLER.
Manganese-iron industry of Southern Russia.
Rev. Univ. des Mines de la Métallurgie, 1899, Juillet, vol. 47, pp. 69-77.
Abst., Stahl u. Eisen, 1899, Oct. 15, vol. 19-II, pp. 953-55.
J. Iron & Steel Inst., 1899-II, vol. 56, p. 518.

1900—SIMON, A., Bordeaux.
Apparatus for production of manganese, ferro-manganese and alloys of manganese.
British Pat. 17190, Sept. 27, 1900.
Abst., J. Soc. Chem. Ind., 1901, vol. 20, pp. 256-7. (Ills.)

1901—STEAD, J. E.
Crystals of carbo-silicide of manganese and iron.
J. Iron & Steel Inst., 1901-I, vol. 59, pp. 79-88.

1902—DUBOIS, R.
Decomposition of ferro-manganese (80 per cent Mn) on standing in the open for a couple of months.
Bull. Assoc. Belge des Chimistes, 1902, vol. 15, p. 221.
Abst., Stahl u. Eisen, 1902, vol. 22, p. 989.
J. Iron & Steel Inst., 1902-II, vol. 62, pp. 553-54.

GIN, G., Paris.
Process for the manufacture of ferro-manganese with simultaneous production of alkaline and earth-alkaline oxides.
German Pat. 147311, March 8, 1902.
Abst., Z. angew. Chemie, 1903, vol. 16, No. 51, p. 1235.

1903—NASKE, TH., and WESTERMAN, A.
Contribution to the knowledge of commercial ferro-manganese.
Stahl u. Eisen, 1903, Feb. 15, vol. 23-I, pp. 243-48.
Abst., J. Iron & Steel Inst., 1903-I, vol. 63, pp. 711-12.

1904—SCHOLL, G. P.
The manufacture of ferro-alloys in the electric furnace.
Electrochem. Industry, 1904, Nov., vol. 2, p. 451.

1904—WITTMAN, F.
The composition of slags in the manufacture of ferro-manganese.
Stahl u. Eisen, 1904, Jan. 1, vol. 24, pp. 14-16.
Abst., J. Iron & Steel Inst., 1904-I, vol. 65, pp. 678-9.

1905—ANONYMOUS.
Elliptic charcoal blast furnace at Nishnji-Tagil (Ural, Russia).
Stahl u. Eisen, 1905, May 15, vol. 25, No. 10, pp. 617-18.

LEVIN, M., and TAMMANN, G.
On manganese-iron alloys.
Z. anorg. Chemie., 1905, vol. 47, pp. 136-144.

SIMMERSBACH, O.
The manufacture of ferro-manganese.
Berg.-u. Hüttenmännische Rundschau, 1905, p. 305 et seq.
Abst., J. Iron & Steel Inst., 1905-II, vol. 68, p. 680.

1906—ANONYMOUS.
The manufacture of ferromanganese in France.
Génie Civil, 1906, vol. 48, p. 243.

DOERNICKEL, F.
Compounds of manganese with silicon.
Z. anorg. Chemie, 1906, vol. 50, pp. 117-126.
Abst., J. Soc. Chem. Ind., 1906, vol. 25, pp. 886-87.

HOLLMANN, E.
The smelting of manganese ore in the blast furnace.
Berg.-u. Hüttenmänn. Rundschau, 1906, vol. 11, pp. 135, 153, 167.
Abst., J. Iron & Steel Inst., 1906-II, vol. 72, pp. 822-23.

LEDEBUR, A.
Handbuch der Eisenhüttenkunde.
Zweite Abtl.: Das Roheisen und seine Darstellung
1906, Leipzig, Verlag von Arthur Felix, 5te Auflage, pp. 229-34.

ROBERTS, ED. G., and WRAIGHT, E. A.
The preparation of carbon-free ferro-manganese.
J. Iron & Steel Inst., 1906-II, vol. 70, pp. 229-86.
The most complete monography ever written on the subject matter.

VENATOR, W.
The supply of manganese ore.
Stahl u. Eisen, 1906, Jan. 15, vol. 26, No. 2, pp. 65-71.

NEUMANN, BERN.
Elektrometallurgie des Eisens.
Halle a/S. Verlag von W. Knapp, 1907, p. 161: Ferro-manganese.

1907—ROMBACHER HUTTENWERKE, W. SCHEMANN, and J. BROWN, Rombach (Germany).
Process for the manufacture of malleable iron and steel and other alloys of iron (viz., ferro-manganese) and apparatus relating thereto.
British Pat. 25400, Nov. 15, 1907. French Pat. 384077, Nov. 16, 1907. U. S. Pat. 915488, March 16, 1909.
Abst., J. Soc. Chem. Ind., 1908, vol. 27, p. 944.

TONE, F. J.
Production of silicides and silicon alloys (silico-ferro-manganese).
U. S. Pat. 842273, Jan. 29, 1907.
Electrochem, Metallurgical Industry, 1907, April, vol. 5, p. 141.

WECKBERKER, J.
New process for the production of manganese alloys.
Bulletin Mensuel Official de l'Assoc. Ingénieurs et

Industriels Luxembourgeois, 1907, July, p. 108 et seq.
Abst., Stahl u. Eisen, 1907, vol. 27-II, pp. 1751-52.

1908—Bauermann, H.
Iron and steel at the Franco-British Exhibition.
III. Special alloy pig irons. Spiegel. Ferro-manganese (Analyses).
J. Iron & Steel Inst., 1908-III, vol. 78, pp. 366-68, 369-70.

Betts, A. G.
Metallurgical process; process of making manganese and ferro-manganese.
U. S. Pats. 1908, Dec. 1, Nos. 905280 and 905281.
Abst., J. Soc. Chem. Ind., 1909, vol. 28, No. 1, p. 25.

Guillet, L.
Manganese-iron alloys.
Comptes.-Rendus, 1908, vol. 146, pp. 74-75.
Abst., J. Iron & Steel Inst., 1908-I, vol. 76, p. 409.

Guillet, L.
Microstructure of ferro-manganese.
Revue de Métallurgie, 1908, vol. 5, pp. 313-18.
Abst., J. Iron & Steel Inst., 1908-III, vol. 78, p. 632.

Soc. Anon. "La Néo-Métallurgie."
Direct manufacture in the electric furnace of metallic manganese melted, refined and poor in carbon.
French Pat. 386442, Jan. 22, 1908; British Pat. 28003, Dec. 23, 1908.
Abst., J. Soc. Chem. Ind., 1908, vol. 27, No. 13, p. 692.

Stadeler, A.
Notes on manganese and its compounds with carbon.
Metallurgie, 1908, vol. 5, pp. 260-67, 281-88.
Abst., J. Soc. Chem. Ind., 1908, vol. 27, No. 11, p. 572.

Stassano, Er.
Treatment of iron and steel in the electric furnace.
Electrochem. Metall. Industry, 1908, Aug., vol. 6, No. 8, p. 316.
Report on the production of a 62 per cent ferro-manganese from a mixture of manganese ore, charcoal and lime in the Stassano electric furnace.

1908—Turner, Th.
The metallurgy of iron.
3d edition, 1908, London, Ch. Griffin & Co., Ltd., pp. 180-81: Reduction of manganese.

Venator, W.
On ferro-alloys and metals for the steel industry.—Ferro-manganese.
Stahl u. Eisen, 1908, Jan. 8, No. 2, pp. 43-48.
Iron & Coal Trades Rev., 1908, vol. 76, p. 520.
Production; statistical data.

1909—Gin, G.
Decarburization of ferro-alloys.
Trans. Amer. Electrochem. Soc., 1909, vol. 15, pp. 225-26.

Jakobi, J.
Production of ferro-manganese in the blast furnace.
Report of practical results obtained in a blast furnace works of Southern Russia.
Stahl u. Eisen, 1909, July 21, vol. 29-II, pp. 1119-20.

Ruthenburg, M., London.
Treatment of manganese and chromium ores containing iron.
British Pat. 6529, March 18, 1909.
Abst., J. Soc. Chem. Ind., 1910, vol. 29, No. 8, p. 496.

Wraight, E. A.
The preparation of carbon-free ferro-manganese. (Further experiments.)
J. Iron & Steel Inst., Carnegie Scholarship Memoirs, 1909, vol. 1, pp. 143-60.

1910—Arnold, J. O.
The chemical and mechanical relations of iron, manganese and carbon.
J. Iron & Steel Inst., 1910-I, vol. 81, pp. 169-84; plates VII and VIII.

Brackelsberg, C. A., Stockholm.
Purification of iron and manganese ores from arsenic, antimony, copper, lead, zinc, sulphur, etc.
German Pat. 241321, Dec. 10, 1910; French Pat. 437250, Dec. 6, 1911; British Pat. 27451, Dec. 7, 1911; U. S. Pat. 1103258, July 14, 1914.
Abst., J. Soc. Chem. Ind., 1912, vol. 31, No. 3, p. 136.

Cöln-Müsener Bergwerks-Aktien-Verein, Creuzthal (Westphalia).
Process for the preparation of manganese minerals and new products resulting therefrom.
French Pat. 419144, Aug. 10, 1910; British Pat. 18945, Aug. 11, 1910.
Abst., J. Soc. Chem. Ind., 1911, vol. 30, No. 2, p. 94.

1910—Lütke, H.
Iron-manganese-carbon alloys.
Metallurgie, 1910, vol. 7, pp. 268-73.
Abst., J. Iron & Steel Inst., 1910-II, vol. 82, p. 530.

Metallbank und Metallurgische Ges. A.-G.
Process for the agglomeration of oxide ores and metallurgical products, especially iron ore, manganese ore, burnt pyrites and flue dust.
German Pat. 241464, Feb. 22, 1910 (addition to Ger. Pat. 210742, Oct. 28, 1905).
Abst., J. Soc. Chem. Ind., 1912, vol. 31, No. 3, p. 136.

1911—Brown, J., and Scheumann, W. Rombach.
The remelting of ferro-manganese and the deoxidation with molten ferro-manganese.
Stahl u. Eisen, 1911, Aug. 24, vol. 31, pp. 1375-76.
Abst., Met. Chem. Engng., 1911, vol. IX, No. 11, p. 575.

Isabellen-Hütte Ges, m.b.H., Dillenberg.
Process for obtaining metallic manganese by means of carbonaceous reducing agents.
German Pat. 250035, April 8, 1911; British Pat. 8400, April 9, 1912; U. S. Pat. 1078199, Nov. 11, 1913.
Abst., J. Goc. Chem. Ind., 1912, vol. 31, No. 12, p. 933.

Lang, G.
Production of ferro-manganese low in phosphorus from manganese ores or ferro-manganese containing phosphorus.
German Pat. 252166, Feb. 7, 1911.
Abst., J. Soc. Chem. Ind., 1913, vol. 22, No. 1, p. 29.

Rombacher Hüttenwerke and J. I. Brown.
Furnace for melting and keeping molten ferro-manganese and other alloys of iron.
French Pat. 434120, Sept. 11, 1911; U. S. Pat. 1056456, March 18, 1913, and U. S. Pat. 1061016, May 6, 1913.

Abst., J. Soc. Chem. Ind., 1912, vol. 31, No. 5, p. 236.

SCHROEDER, F.
Remelting of ferro-manganese in the electric furnace and the use of molten ferro-manganese for deoxidation.
Stahl u. Eisen, 1911, Sept. 11, vol. 31, pp. 1457-62.
Abst., Met. Chem. Engng., 1911, vol. IX, No. 12, pp. 640-41.
J. Iron and Steel Inst., 1912-I, vol. 85, p. 540.

SCHÜPANS, H.
The composition of ferro-manganese blast furnace charges and the cost of production of ferro-mangansese.
Berg. u. Hüttenmännische Rundschau, 1911, Nov. 5, p. 21.
Stahl u. Eisen, 1912, May 9, vol. 32, No. 19, pp. 794-96.

SOC. ANON. DES CIMENTS PORTLAND ARTIFICIELS DE BUDA.
Process for treatment of pulverulent ores of iron and manganese.
French Pat. 428366, April 11, 1911.
Abst., J. Soc. Chem. Ind., 1911, vol, 30, No. 19, pp. 1166-67.

1912—GESELLSCHAFT FÜR ELEKTROSTAHLANLAGEN M.B.H.
and W. RODENHAUSER.
Lining for electric furnaces for the production of ferro-manganese, ferro-silicon and other alloys.
German Pat. 269298, July 26, 1912; French Pat. 463334, Oct. 7, 1913.
Abst., J. Soc. Chem. Ind., 1914, vol. 33, No. 6, p. 319.

HILPERT, S., and DIECKMANN, T.
Ferro-magnetic compounds of manganese.
Ber. der Deutsch. Chem. Ges., 1912, vol. 44, pp. 2831-35.
Abst., J. Iron and Steel Inst., 1912-I, vol. 85, pp. 587-88.

KELLER, C. A.
Electrometallurgical manufacture of ferro-chromium or other metals (viz., ferro-manganese) from metallurgical slags free from iron.
French Pat. 461098, Oct. 21, 1912.
Abst., J. Soc. Chem. Ind., 1914, vol. 33, No. 4, p. 204.

KORTEN, R.
The remelting of ferro-manganese in the electric furnace.
Stahl u. Eisen, 1912, March 14, vol. 32, pp. 425-32.
Abst., J. Soc. Chem. Ind., 1912, vol. 31, No. 7. p. 338.
J. Iron and Steel Inst., 1912-I, vol. 85, p. 541.

1913—BUDDEUS, W.
Process for roasting and sintering ores and metallurgical products, *e. g.*, iron and manganese ores, pyrites cinder, blende, etc.
German Pat. 273277, Jan. 16, 1913.
Abst., J. Soc. Chem. Ind., 1914, vol. 33, No. 13, p. 700.

VIELAJUS, J. M.
Process for the application of slags or residues from the preparation of alloys of manganese, silicon and iron in the electric furnace to the manufacture of artificial Portland cement.
French Pat. 463362, Oct. 7, 1913.
Abst., J. Soc. Chem. Ind., 1914, vol. 33, No. 8, p. 422.

1914—ANONYMOUS.
The cost and the advantages of using electrically melted ferro-manganese.
Met. Chem. Engng., 1914, vol. 12, pp. 295-96.

HILPERT, S., and DIECKMANN, T.
The higher phosphides of manganese.
Ber., 1914, vol. 47, pp. 780-84.

HONDA, K., and SONÉ, T.
Magnetic susceptibility of manganese oxides.
Science Reports of the Tôhoku Imperial University, 1914, vol. III, pp. 139-52.
Abst., J. Iron and Steel Inst., 1914-II, vol. 90, p. 379.

HUMBERT, E., Chicago (Ill.).
Method of melting ferro-manganese.
U. S. Pat. 1101551, June 30, 1914.

INDENKEMPEN, E.
The economic factor of the various ferro-manganese melting furnaces.
Stahl u. Eisen, 1914, vol. 34-I, pp. 803-06.
Particulars of cost of working are given.

LENOIR, C. L.
Production of manganese and its alloys in the electric furnace.
French Pat. 474927, Jan. 8, 1914.
Abst., J. Soc. Chem. Ind., 1915, vol. 34, p. 1099.

LYON, D. A., KEENEY, R. M., and CULLEN, J. F.
The electric furnace in metallurgical work.
Bureau of Mines Bulletin No. 77, Washington, 1914, pp. 141-46.
Iron Age, 1915, March 4, vol. 95, pp. 539-540.

RUFF, O., BORMANN, W., and KEILIG, F.
Manganese, nickel, iron and cobalt, respectively, and carbon. (Researches in the field of high temperatures.)
Z. anorg. Chem., 1914, vol. 88, pp. 365-423.

SAHLIN, A., Brussels.
Use of liquid ferro-manganese in steel processes. (Remelting in electric furnaces.)
J. Iron and Steel Inst., 1914-II, vol. 90, pp. 213-231.

THALER, H.
Reduction of manganese in the blast furnace. (Experimental investigation of the manufacture of spiegeleisen.)
Stahl u. Eisen, 1914, vol. 34, pp. 1481-84.

WALKER, J. C., Yonkers.
Method of making an alloy of ferro-manganese and silicon.
U. S. Pat. 1109640, Sept. 1, 1914.

1915—ANONYMOUS.
Ferro-manganese supplies.
Statistical data on imports, production and consumption.—Effect of the war.
Iron Age, 1914, March 4, vol. 95, p. 514.

1915—OSANN, B.
Lehrbuch der Eisenhüttenkunde.
Vol. 1: Roheisenerzeugung.
Leipzig, 1915, pp. 497-99.
Heat balance sheet of a ferro-manganese blast furnace for 100 kg. ferro-manganese, on the basis of the analysis of the flue gases. Pp. 542-43: Analysis of slags. Pp. 638-42.

RODENHAUSER, W.
Ferromangan als Desoxidations mittel im festen und flüssigen Zustande und das Ferromanganschmelzen (im elektrischen Ofen).
1915, Leipzig, Verlag von Oskar Leiner, 124 pp.
The most complete monography on ferro-manganese ever published. The manufacture of ferro-manganese in the electric furnace is exclusively dealt with. Numerous cost data.

1917—ANDERSON, R. J.
Ferro-manganese in the iron and steel industry.
Jour. Franklin Institute, 1917, May, vol. 183, pp. 579-592. (Contains bibliography on manganese ore deposits.)

ANDERSON, R. J.
Metallurgy of ferro-manganese.
Iron Trade Rev., 1917, March 29, vol. 60, No. 13, pp. 723-726.

NOLLY, H. DE.
Electric furnace for fusing ferro-manganese or other metals.
U. S. Patent No. 1216961, Feb. 20, 1917.

Laboratory Methods for Benzol-Recovery Plant Operation—III

By F. W. Sperr, Jr.
Chief Chemist, H. Koppers Co.
(*Concluded from Page 588*)

Method for Determining the Specific Gravity of Benzols

For routine purposes the test is made by means of a Westphal balance.

Cool the oil to about 12 deg. C., rinse out the cylinder with a portion of the oil; suspend the plummet from the balance into the cylinder, and fill the latter with the cold oil. When the temperature, as shown by the plummet thermometer, is almost 15.5 deg. C., place weights on the beam and adjust rapidly at 15.5 deg. C. The specific gravity may also be determined by the pyknometer, but extra precautions have to be taken on account of the high coefficient of expansion of the benzols.

Sulphuric Acid Color Test for Benzol, Toluol, Solvent Naphtha, Etc.[1]

The set of color standards consists of fifteen sealed tubes, approximately 1 in. diameter, each containing one of the solutions made up as given below.

When making a test for amount of acid washing, a glass-stoppered weighing bottle about 1 in. diameter and 2 ½ in. high is used (E. H. Sargent No. 802[2]). One cc. of concentrated (1.84 sp. gr.) sulphuric acid is put in first and then approximately 21 cc. of the material to be tested is added. Shake thoroughly for 15 to 20 sec., and allow to stand for specified time. Compare the resulting color of the acid layer with the standard set, and determine to which number it corresponds.

In pure benzol and pure toluol testing, the benzol or toluol layer must remain white, and the color of the acid layer, after standing 15 min., must not be darker than No. 4.

[1]Gas Chemists Handbook, p. 187.

[2]One ounce glass stoppered "French Squares" are usually prescribed. We have found the round bottles with straight sides easier to clean.

For 90 per cent benzol and all grades of benzol and toluol other than pure, the benzol and toluol layer must remain white and the color of the acid layer, after standing 15 min., must not be darker than No. 6.

For solvent naphtha the acid layer color only is noted. After 5 min. standing it must no tbe darker than No. 14.

In making the test it is customary to take the color of the main portion of the acid, and should a darker ring form—just below the benzol or toluol—this is disregarded.

The solutions for the standards are made up as follows: The following basic solutions are used:

A. 59.4965 gr. $CoCl_2$ $6H_2O$ (nickel free) is made up to 1000 cc. with a mixture of 25 cc. 31 per cent HCl and 975 cc. H_2O.

B. 45.054 gr. $FeCl_3$ $6H_2O$ made up to 1000 cc. with a mixture of 25 cc. 31 per cent HCl and 975 cc. H_2O.

C. 3.5 volumes of solution A + 36.5 volumes solution B + 90 volumes of H_2O.

D. 3.5 volumes of solution A + 36.5 volumes of solution B (no water is added).

E. Solution of K_2CrO_4 saturated at 21 deg. C.

F. 1 volume of a solution of $K_2Cr_2O_7$ saturated at 21 deg. C. + 1 volume of H_2O.

As standard color solutions to be used for comparison the following are made up and numbered from 0 to 14.

No. 0. Pure water.
No. 1. 1 volume of solution C + 1 volume of H_2O.
No. 2. 5½ volumes of solution C + 2 volumes of H_2O.
No. 3. Solution C as such.
No. 4. 1 volume of solution D + 1 volume of H_2O.
No. 5. 5½ volumes of solution D + 2 volumes of H_2O.
No. 6. Solution D as such.
No. 7. 5 volumes of solution E + 2 volumes of H_2O.
No. 8. Solution E as such.
No. 9. 7 volumes of solution E + ½ volume of solution F.
No. 10. 6½ volumes of solution E + 1 volume of solution F.
No. 11. 5½ volumes of solution E + 2 volumes of solution F.
No. 12. 1 volume of solution E + 1 volume of solution F.
No. 13. 2 volumes of solution E + 5 volumes of solution F.
No. 14. Solution F as such.

Tests of Washed Benzol

These tests are made on samples of benzol from the agitator, which is used for the sulphuric acid treatment of the crude distillates. The object of the test is to determine whether a sufficient degree of purification has been attained by the acid treatment.

WASH TEST FOR BENZOL AND TOLUOL

It is presumed that the benzol or toluol or mixture of both has been agitated with sulphuric acid and the latter removed after the customary settling. Transfer about 350 cc. of the sample into a 500-cc. separatory

funnel; add about 30 cc. tap water; shake about 30 sec. and allow to settle. Drain off water and impurities. Add about 30 cc. of a 1.10 sp. gr. solution of NaOH (95 grams per liter), agitate about 50 sec. or until the mixture develops a yellowish color. Let settle and drain off soda and impurities. Add about 30 cc. of tap water; agitate about 30 sec.; let settle and drain off water, leaving the completely washed benzol and toluol in the funnel. Add between 5 and 10 grams of fused $CaCl_2$, agitate for a few seconds, and allow to settle until the oil clears. Transfer through the mouth of the funnel about 60 cc. of the oil into a clean 100-cc. distillation flask, previously rinsing flask with the same oil, exercising care to prevent benzol from getting into the side neck of the flask. Connect to a clean condenser and distil to about 80 deg. C., catching distillate in a clean test tube. Quickly reject this distillate from the test tube and continue distillation to 95 deg. C. in case of benzol or to 115 deg. C. in case of toluol or a mixture of benzol and toluol. The sulphuric acid color test is then made on a portion of the distillate as described in the preceding test. Care must be taken to test each lot of $CaCl_2$ for impurities that might affect the results.

WASH TEST FOR SOLVENT NAPHTHA

It is presumed that the solvent naphtha has been agitated with sulphuric acid; has been allowed to settle, and separated. Transfer about 350 cc. to a 500-cc. separatory funnel; add about 25 grams of CaO (pulverized). Shake about 1 min. and allow to settle. Rinse a clean 100-cc. distilling flask with a portion of the solvent and distil 60 cc. to 180 deg. C., using a clean condenser and test tube for the distillate. The sulphuric acid color test is then made on a portion of the distillate as described above.

Test for Sulphur Dioxide and Sulphur Trioxide in Washed Benzols

Place the oil to be tested in a bottle, filling the bottle not more than half. Cork and shake well; then uncork and quickly place a piece of moist test paper in the mouth of the bottle, holding by the fingers or by carefully replacing the cork. The paper must in any case be exposed to the vapors above the oil. The test is quite sensitive and color change will be noted almost immediately if SO_2 or SO_3 are present. The test paper will change from a yellow to a red if SO_3 or SO_2 are present.

ALTERNATE METHOD

This test can very conveniently be made in connection with the test for completeness of washing with acid. Before distillation of the washed light oil is made, place an adapter on the end of the condenser, and place a piece of the moist test paper in the top of the adapter in such a manner that the paper is exposed to the vapors, but not to the stream of condensed liquid. The moist paper will adhere quite readily to the walls of the adapter. Continue with distillation and note color change if SO_3 or SO_2 are present.

To Make Test Papers—Make a solution of methyl orange by placing 0.1 gm. of it in 100 cc. water, shaking it at intervals and finally allowing to stand over night. Finally filter off any solid matter and use the clear liquid for making test papers. Cut up filter paper into narrow strips (paper free from sulphites and acids should be used) and dip into the methyl orange solution. Shake off excess solution, as the test gives best results with moist paper, i.e., paper that has no drops of excess solution adhering to it.

Approximate Determination of Unsaturated Compounds in Washed Benzol by Bromine Titration[2]

A measure of the quantity of unsaturated compounds (hydrocarbons of the ethylene and acetylene series, etc.) present in crude benzol is afforded by titration with bromine. The bromine water formerly used for this purpose is best replaced by a solution of potassium bromide and bromate, which, on addition of sulphuric acid, sets free 8.0 gr. of bromine per liter. The test is carried out by Frank in the following manner:

5 cc. of the sample are added to 10 cc. of dilute sulphuric acid (1:5) contained in a 50-cc. bottle provided with a glass stopper, and N/10 bromine bromate solution containing 9.9167 gr. KBr + 2.7833 gr. $KBrO_3$ per liter is added from a burette until, after 5 minutes' shaking, bromine still remains. The titration is finished when the floating oil remains orange-red in color after standing for 15 minutes, and when one drop gives a dark blue coloration with freshly prepared potassium iodide starch paper. The quantity of bromine used (1 cc. = 0.008 gr. Br) should be reported as grams Br per 100 cc. of sample. To obtain accurate results, a preliminary determination is first made, and then two exact estimations, the mean of which is taken. Pure benzene and pure toluene should show a marked bromine reaction after the addition of 0.1 cc. of the bromine solution; whilst 90 and 50 per cent benzols will decolorize on an average 0.6 cc. of the reagent, but seldom more than 1 cc. Commercial xylene absorbs 2 per cent bromine in a few minutes and considerably more on standing for some time.

Freezing Point Test of Benzene

The thermometer used is a so-called "titer test" thermometer, graduated to tenths of a degree from 0 deg. to 65 deg. C., and is about 15 in. long. Those in use at present are made by the Taylor Instrument Company, Catalog No. 1425. They should be standardized against the freezing point of water. About 40 cc. of pure benzene is placed in a tube or short cylinder—preferably a titer cylinder, of about 1¼-in. diameter and about 3½ in. high, made of rather thin glass. This is placed in a bath of ice water, and a small amount of salt added. The bath temperature should be about 0 deg. C.

Suspend thermometer in the benzene, stirring constantly. When temperature remains constant about 30 seconds (care must be exercised here not to greatly supercool the benzene; however, with stirring, there is not so much danger of this) allow thermometer to stand with the bulb in the center of the benzene, and allow the mercury to rise. The highest point is the freezing point.

The following comparisons will show the relative sensitiveness of the freezing point and boiling point tests. First samples of pure benzene were tested by the boiling point and freezing point tests with the following results:

[2]Method of Kraemer and Spilker. Muspratt's Encyclopaedia (1905 German Ed.), Vol. 8, p. 33—et seq.

	1 Deg. C.	2 Deg. C.	3 Deg. C.	4 Deg. C.
1 drop	80.15	79.63	79.68	78.72
5 cc.	80.25	80.13	80.06	79.45
10 cc.	80.32	80.21	80.16	79.67
20 cc.	80.35	80.28	80.24	79.92
30 cc.	80.35	80.35	80.31	80.09
40 cc.	80.36	80.39	80.36	80.22
50 cc.	80.36	80.42	80.36	80.27
60 cc.	80.37	80.43	80.36	80.32
70 cc.	80.37	80.47	80.36	80.37
80 cc.	80.38	80.53	80.41	80.42
90 cc.	80.42	80.58	80.46	80.47
95 cc.	80.45	80.68	80.53	80.52
Dry	80.47	80.93	80.61	80.72
Freezing point	5.43	5.15	5.15	4.70

To show the relative effects of small amounts of impurities, comparisons were made on samples of pure benzene to which 0.5 per cent of toluol, petroleum ether and carbon disulphide had been added with the following results.

Portions of sample No. 1 (above) were used.

	Benzene, 99.5% Toluol, 0.5% Deg. C.	Benzene, 99.5% Petroleum Ether, 0.5% Deg. C.	Benzene, 99.5% Carbon Disulphide, 0.5% Deg. C.
1 drop	80.23	79.59	79.18
5 cc.	80.53	80.11	79.68
10 cc.	80.54	80.30	79.88
20 cc.	80.58	80.48	80.08
30 cc.	80.64	80.49	80.18
40 cc.	80.66	80.49	80.26
50 cc.	80.68	80.57	80.34
60 cc.	80.72	80.58	80.41
70 cc.	80.74	80.59	80.43
80 cc.	80.77	80.62	80.45
90 cc.	80.94	80.62	80.48
95 cc.	81.83	80.62	80.48
Dry.	83.35	80.63	80.53
Freezing point	5.2	5.3	5.0

Evaporation Test of Benzols[4]

2 cc. of the benzol are placed on a metal surface with raised edges 3.5 in. square, and the time taken for complete evaporation is noted. In order to allow for variation in temperature this should be compared with pure benzene, which requires 10 minutes for complete evaporation at ordinary laboratory temperatures.

Method for the Determination of Carbon Disulphide in Benzols[5]

Fifty grams of the benzol are mixed with 50 gr. of a solution of potassium hydroxide and absolute alcohol (11 gr. potassium hydroxide and 90 gr. absolute alcohol). The mixture is shaken and allowed to stand several hours at room temperature. About 100 cc. of water are then added. The aqueous solution is separated from the benzol and the latter is washed several times with water. The washings are added to the aqueous solution. The potassium thiocarbonate is determined either in the solution directly or in an aliquot part of the same, by means of a solution containing 12.475 gr. crystallized copper sulphate per liter. One cubic centimeter of this solution is equivalent to 0.0076 grams of carbon disulphide. The aqueous solution is neutralized with acetic acid and the standard copper solution is added until a drop of the solution put on a piece of filter paper, by means of a glass rod, shows a red color when brought in contact with a drop of potassium ferrocyanide. The approach of the end point is made known by a certain agglomeration of the finally divided precipitate of copper thiocarbonate.

The amount of potassium hydroxide solution given above is sufficient for a benzol containing 5 per cent carbon disulphide, but for larger percentages of carbon disulphide the quantity of potassium hydroxide must be increased, or else a smaller sample of benzol must be taken.

It is important to run a careful blank on the reagents used.

Determination of Hydrogen Sulphide in Light Oil

Place 50 cc. of the light oil in a separatory funnel, and shake thoroughly with a mixture of 20 cc. normal sodium hydroxide solution and 50 cc. of water. After shaking, let the layer separate and draw off the aqueous layer. Wash the light oil again by shaking two or three times with water, separating the aqueous layer each time. Unite the aqueous extracts; dilute to 300 or 400 cc.; add dilute HCl in excess and titrate with N/10 iodine solution, using starch as an indicator. One cubic centimeter N/10 iodine is equivalent to 0.0017 gr. H_2S.

Specifications and Tests of Wash Oil Used for Benzol Recovery

1. Specific gravity at 15 deg. C. must not be over 0.880.

2. The viscosity must not be more than 92 seconds at 21 deg. C., and must not be more than 150 seconds at 4 deg. C., both tests to be made in a Saybolt viscosimeter. No solid matter must separate at 4 deg. C.

3. At least 95 per cent of pure oil should separate from the water in 10 minutes, and the oil should not contain more than 0.5 per cent water in the separated oil when the following test is made.

Twenty cubic centimeters distilled water and then 100 cc. of the oil are placed in a graduated 250-cc. cylinder. Steam is bubbled through the two liquids by means of a glass tube whose inside diameter is approximately 3/16 in. After steaming 10 minutes, the cylinder and its contents are placed in a water bath at 15 deg. C. for 10 minutes, and the volume of separated oil is read. To determine the amount of pure oil separated and water content of the separated oil, draw off the oil by means of a pipette, taking care to get none of the water layer; shake the oil thoroughly; take 20 cc. and mix with 80 cc. pure solvent naphtha in a graduated precipitating tube having the lower end drawn out and graduated 1/10 of 1 cc. This oil-solvent naphtha mixture is kept at a temperature of not over 80 deg. F. for one hour, or the mixture may be separated by means of a centrifuge. The amount of water separated is then read.

4. The oil must not contain more than 12 per cent olefines as determined by the following test:

The apparatus consists of a glass-stoppered flask having a 100-cc. mark at the bottom of the neck and a 110-cc. mark at the top of the neck. (This is listed as a "Cassia flask" by most dealers in chemical apparatus.) The space between these two marks is divided into 1/5 cc. or 1/10 cc. Special sulphuric acid is prepared by mixing one part of fuming sulphuric acid (containing 25 per cent SO_3) with two parts of concentrated sulphuric acid containing 93 per cent H_2SO_4.

Ten cubic centimeters of the wash oil are exactly measured by a burette into the 100-cc. graduated flask and shaken vigorously with 25 cc. of the special acid. After standing for one hour, fill the flask to the 110-cc.

[4] Jour. Ind. and Eng. Chem., Vol. 3, p. 11.
[5] A. Spilker, Kokerei und Teerprodukte der Steinkohle.

mark with concentrated sulphuric acid. The acid should be added by pouring it slowly against the neck of the flask in order to avoid agitating the already settled mixture. Allow the mixture to stand for two hours and then read the amount of the paraffins left. The difference gives the amount of olefines in the original 10 cc. of oil.

5. Not more than 5 per cent of the oil should distil under 250 deg. C., and an additional 85 per cent should distil within 120 deg.

NOTES ON SPECIFICATION TESTS

Specific Gravity: The test is made with a Westphal balance. In setting up the balance, the screw in the base of the balance is adjusted so that the two pointer protuberances are exactly on the same level when the thermometer is suspended at the end of the beam. The height of the beam can be regulated by the screw in the vertical support so that the plummet does not touch the bottom of the glass cylinder. The weights consist of four sizes. The largest size hung on the hook at the end of the beam gives units; on any other space gives tenths; the next size indicates hundredths; the next thousandths, and the smallest ten-thousandths of specific gravity.

After cooling a sample of the oil to about 10 deg. C., the cylinder is rinsed with the oil; the suspended plummet inserted in the cylinder, which is filled with the cooled oil. The weights are placed on the various divisions and so adjusted that when the thermometer indicates 15.5 deg. C., the two pointer protuberances are on the same level. (After the specific gravity figure is obtained, the plummet and cylinder are rinsed with benzol.)

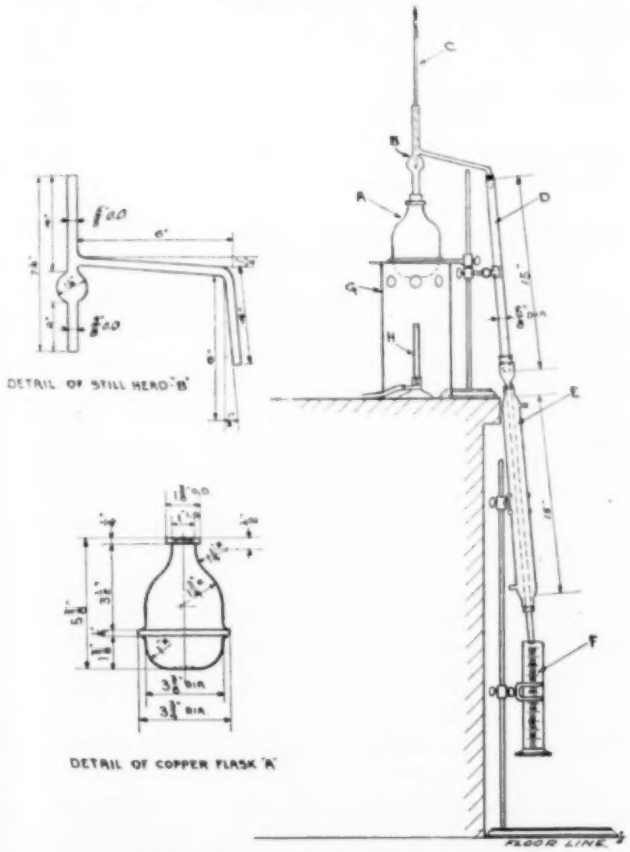

FIG. 6—APPARATUS FOR DISTILLATION OF STRAW OIL

A. 500 cc. copper flask (Eimer & Amend, 3018—E. H. Sargent No. 1938.)
B. Still head.
C. 400 deg. C. thermometer.
D. Glass Air condenser.
E. 15-in. Liebig condenser.
F. 100 cc. graduate.
G. Asbestos or sheet iron shield.
H. Standard Bunsen or Teclu burner.

Distillation: The distillation is made in the apparatus described in Fig. 6, using 200 cc. of the oil as a sample. The temperature is recorded for the following quantities of distillate.

First Drop	
10 cc.	5 per cent
20	10
40	20
60	30
80	40
100	50
120	60
140	70
160	80
180	90

Olefines: The special acid, equivalent to two parts 93 per cent H_2SO_4 and one part of fuming sulphuric acid containing 25 per cent free SO_3 by volume, may be prepared from acid of their strengths according to the following method:

According to Van Nostrand's "Chemical Annual," 93 per cent H_2SO_4 contains 1393 gr. SO_3 per liter. The 25 per cent fuming sulphuric acid contains 86.22 per cent total SO_3. Calculation shows that the acid required contains 1485 gr. SO_3 per liter. An example will illustrate the calculations necessary to prepare this acid.

To make up 1000 cc. H_2SO_4 containing 1485 gr. per liter of SO_3 from 95 per cent (conc.) H_2SO_4 and fuming H_2SO_4 (15 per cent free SO_3).

Then: Let X = number of cubic centimeters of 95 per cent acid required

1000 — X = number of cubic centimeters of 15 per cent free SO_3 acid required

Total SO_3 in X cc. of 95 per cent H_2SO_4 = 1.426 X gr.

15 per cent fuming acid contains 84.39 per cent total SO_3

Specific gravity of 15 per cent fuming acid is 1.918

SO_3 in (1000 — X) cc. of 15 per cent fuming H_2SO_4 = $0.8439 \times 1.918\ (1000 - X)$ gr.

$1.426\ X + 0.8439 \times 1.918\ (1000 - X) = 1485$

X = 696 cc. 95 per cent (conc.) H_2SO_4

1000 — X = 304 cc. 15 per cent free SO_3 fuming H_2SO_4.

The Determination of Light Oil in Benzolized and Debenzolized Wash Oil

BENZOLIZED WASH OIL

One liter of the benzolized oil is transferred to a ½-gallon copper still. The still is connected to a 15-in. condenser leading into a 500-cc. separatory funnel described in method for "Determination of Light Oil in Gas." (Fig. 2.) The oil is heated to about 140 deg. C. with a burner, and live steam is then conducted through the oil at such a rate that the distillate comes over quite rapidly, but not in a continuous stream. Unusual care

should be taken to attach the cover to the top of the still in such a way that the latter does not leak. The presence of a leak, no matter how slight, will produce false results. The lid, provided with a firm cardboard gasket, should be fastened on as tightly as possible, and the space between the edge of the lid and the thread of the still should be wrapped tightly with asbestos cord. This wrapping of asbestos cord can be made absolutely vapor-tight by cementing with sodium silicate; but this is not always necessary.

The oil should be submitted to the steam distillation until one liter of water is condensed in the funnel. The distillate of oil in the funnel is then drained free of water and is agitated with about 10 cc. of a saturated solution of $CaCl_2$, which is finally drawn off. The inside of the stem of the funnel is wiped thoroughly dry by means of a pellet of raw cotton and the oil distillate is transferred to a 100-cc. flask (Fig. 3), in which it is dry distilled to 200 deg. C., the distillate being received in a graduated test tube.

$$\frac{\text{No. cc. of distillate up to 200 deg. C.} \times 100}{1000} =$$

per cent light oil in the benzolized absorbent oil.

DEBENZOLIZED WASH OIL

The procedure is similar as with the benzolized wash oil, with the exceptions that a sample of six to eight liters is used. This is distilled in a similar still, and the distillation is considered complete when two liter of water have condensed in the separatory funnel.

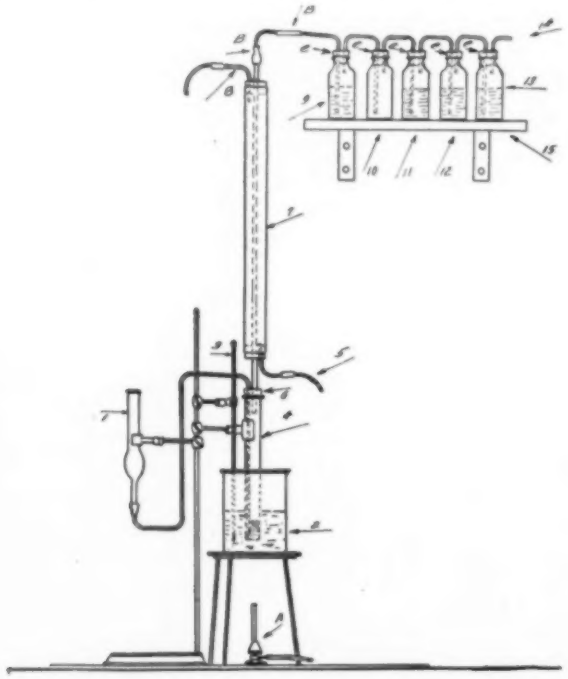

FIG. 7—APPARATUS FOR THE DETERMINATION OF NAPHTHALENE IN OILS

1. Guard Tube 4 in. to 6 in. connected.
2. 600 cc. Beaker.
3. Thermometer.
4. Flat bottomed test tube, 8 in. x 1 in.
5. Water inlet.
6. 2-hole rubber stopper.
7. Condenser.
8. Water outlet.
9. $\frac{N}{1}$—Sulphuric Acid.
10. Empty bottle.
11. 150 cc. sat. picric acid sol.
12. 150 cc. sat. picric acid sol.
13. 150 cc. sat. picric acid sol.
14. Connection to suction.
15. Shelf.

B. Rubber connection.
A. Bunsen burner.

Determination of Naphthalene in Oils[6]

The apparatus is shown in the accompanying sketch (Fig. 7).

The sample, about 10 gr. (the quantity depending upon the approximate naphthalene content[7]) is accurately weighed and placed in the test tube 4 which is an 8-in. by 1-in. flat-bottom test tube. 1 is a 6-in. calcium chloride tube (empty) which serves as a guard, connected as shown by glass tubing through the two-holed rubber stopper (6), practically to the bottom of the flat-bottom test tube. The guard tube serves as a safety device in case the oil is blown out. It also serves as the air inlet for the air which passes through the oil and carries out the naphthalene. 7 is a water-jacketed condenser having an 18-in. water jacket and an inner tube 12 mm. This conveys over the air with the naphthalene but returns the oil to the test tube. 5 is the water inlet and 8 is the outlet. 9 is a wide mouth salt bottle containing about 200 cc. N/1 sulphuric acid. This bottle will trap any tarry or alkaline substances. 10 is an empty bottle serving as a trap for any solvent carried over. 11, 12 and 13 are wide-mouthed salt bottles fitted with two-holed rubber stoppers, each containing 150 cc. of a saturated solution of picric acid. 14 is the connection to suction.

The sample is placed into the test tube (4) and the apparatus connected and the suction turned on so that air bubbles through the oil at about 1½ cu. ft. per hour. Water is turned on in the condenser. The burner is placed under the beaker containing the water and heated slowly until the water boils, and then is continued for one hour. Then the flame is turned out and the air is allowed to bubble over night.

PREPARATION OF THE BENZOL SOLUTION OF NAPHTHALENE PICRATE

Transfer the picric acid solution and the precipitate to a liter separatory funnel, the residues being washed in with naphthalene free benzol. Shake gently the contents of the funnel until the precipitate is completely dissolved in the benzol. Reject the aqueous layer and draw the benzol solution into a 250 cc. measuring flask. Make up to the mark with benzol and thoroughly mix.

DETERMINATION OF THE TOTAL PICRIC ACID

Titrate 50 cc. of this solution—preferably in a 200-250-cc. separatory funnel, for shaking is necessary—with N/5 NaOH, using methyl red as the indicator. This titrates both the free and the combined picric acid.

If T = cubic centimeters N/5 NaOH required for this total titre

Then 5T = cubic centimeters N/5 NaOH required for the total titre of the whole solution.

(To prepare methyl red indicator dissolve 2 gr. methyl red in 1 liter of a mixture of two parts grain alcohol and one part water.)

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[6] Adapted from the method for Naphthalene in Gas, Gas Chemists Handbook, 1916.

[7] Enough naphthalene should be present to saturate the picric acid in the first absorption bottle. This is important for obtaining accurate results. When too little naphthalene is present the results will tend to be too high. In such cases we have found it desirable to add a measured volume of benzol containing a known amount of naphthalene to the solution in the 250cc flask before making up to the mark. This is readily corrected for in the final result.

DETERMINATION OF THE FREE PICRIC ACID

The free picric acid present is determined by the following procedure:

From a burette draw $\frac{T}{1200}$ cc. of the benzol solution into a 100-cc. flask and evaporate to dryness to remove the benzol, proceeding carefully according to the following directions. The flask is placed in hot water bath, and a current of air passed over (not in) the benzol solution, at no time allowing the level of the hot water to be above the level of the benzol solution. The flask should be gently shaken during the evaporation to keep the walls moist and to avoid overheating any part. Keep the flask about one minute in the hot water after the residue appears dry, then remove, but continue the air current until the odor of benzol can no longer be detected.

Dissolve the residue in the flask with 10 cc. of 95 per cent alcohol, heating gently if necessary, then precipitate the naphthalene picrate with distilled water, adding it slowly with agitation until the volume is 100 cc. The temperature of this solution must be cooled to 20 deg. C. In no case more than 2 deg. higher or lower.

Filter through a dry filter into a 100-cc. cylinder and titrate 90 cc. of the filtrate with N/5 NaOH, using methyl red as the indicator.

The cubic centimeters of N/5 NaOH taken divided by 0.9 gives the titre required for the free acid (picric) in $\frac{1200}{T}$ cc. of the original benzol solution.

If F = cubic centimeters N/5 NaOH required for this $\frac{1200}{T}$ cc.

Then $F \times \frac{250}{\frac{1200}{T}}$ = NaOH required for the free picric acid in the whole benzol solution.

CALCULATION FOR THE NAPHTHALENE FROM THE PICRIC ACID TITRES

The difference between the total titre and the free acid titre is the titre of the picric acid combined as naphthalene picrate, and this latter titre multiplied by its naphthalene equivalent gives the grams naphthalene in the sample.

Total titre — Free acid titre; Grams naphthalene equivalent to 1 cc. N/5 NaOH

$$\left\{ 5T - F \times \frac{250}{\frac{1200}{T}} \right\} \times 0.0256 = \text{grams naphthalene in the sample.}$$

or, simplified:

$0.0053T\ (24 - F)$ = grams naphthalene in sample.

and $\frac{0.0053T\ (24 - F)}{\text{grams of sample}} \times 100$ = per cent naphthalene.

NOTES ON THE METHOD

The reactions involved in the method are the following: Naphthalene combines with picric acid to form naphthalene picrate according to the following quotation:

$$C_{10}H_8 + C_6H_2(NO_2)_3OH = C_6H_2(NO_2)_3OHC_{10}H_8 + H_2O$$

$$\underset{C_6H_2(NO_2)_3OH}{\text{Picric Acid}} + NaOH = \underset{C_6H_2(NO_2)_3ONa}{\text{Sodium Picrate}} + H_2O$$

$$C_6H_2(NO_2)_3OH.C_{10}H_8 + NaOH = C_6H_2(NO_2)_3ONa + C_{10}H_8 + H_2O$$

To absorb the naphthalene completely the picric acid solution must be fully saturated, and to insure this an excess of crystals must be present. The reason for taking $\frac{1200}{T}$ of the benzol solution for the free picric acid test is that this is the quantity which contains the right amount of picric acid (1.1 gr.) to saturate the 100 cc. of solution to which it is finally made up, and this saturation is essential to prevent decomposition of the naphthalene picrate present at the stated temperature (20 deg. C.). Naphthalene picrate is easily decomposed by heat, evolving naphthalene and leaving behind free picric acid. A blank should be run on the reagents, using a weighed amount (about 0.1 gr.) of pure naphthalene dissolved in the 250 cc. of benzol.

The Future of Electrolytic Zinc*

By Thomas French

In the last two years a large quantity of high-grade electrolytic zinc has been produced in the United States and Canada, and at the present time many other plants are projected. In view of this rapid progress the question has often been asked: Will the older retort process of smelting be superseded by the electrolytic deposition of zinc?

The reply to this question is generally given in an unqualified negative, apparently justified by the rather unsatisfactory recoveries of zinc obtained by those who have adopted the electrolytic process. The poor recovery is attributed mainly to the difficulty of roasting the ore without the formation of ferrite of zinc, which is very difficult to dissolve in the acid effluent from the electrolytic vats, but also to the difficulty in dealing with the filtration of slimy acid and neutral solutions.

We hear of great variations in the amount of zinc that can be dissolved from the roasted ore. Sometimes a 90 per cent extraction of the zinc in the ore is obtained, and at other times only half, or even less than that amount, from the same ore. The average recovery of zinc appears to be less than 70 per cent by most of those engaged in the manufacture of electrolytic zinc from ores or concentrates containing about 40 per cent zinc.

If an extraction of 90 per cent of the zinc can at times be obtained, and at other times cannot be obtained from the same ore, then assuredly, sooner or later, the reason for the disparity will be found. That being so, and taking into consideration several weighty factors favoring the electrolytic process for the reduction of zinc from its ores, there is more than a strong probability that the retort process for the reduction of zinc is doomed in the near future.

*A paper presented at the Pittsburgh meeting of the American Electrochemical Society, Oct. 3, 1917.

In forming this opinion, one of the chief considerations is that electrolytic zinc is being produced either by lead or copper manufacturers, and may be considered to be a by-product. It is true that some of these manufacturers are treating customs ores, but this is only to take advantage of the very profitable price of zinc which has ruled for some time, and to fulfill large contracts. The primary reason for the erection of these electrolytic plants was to extract from their own ores the zinc which previously had either been wasted or not worked at all.

In the case of the lead smelter, especially those whose ores contain much zinc, it is imperative that the zinc should be extracted, in order that the lead may be profitably smelted. Before long a modern lead smeltery will not be considered complete without the adjunct of an electrolytic zinc reduction plant, if it is within reach of electric power at a reasonable rate. The competition of this by-product zinc will itself seriously affect the output of the retort smelters.

With proper adjustment of the roasting furnace conditions, it is not a difficult matter to obtain extractions of 90 per cent from ores containing 15 per cent to 25 per cent zinc, and in the latter case with as much as 25 per cent of iron. As far as the author's experience goes, furnaces of the Wedge and Herreshoff type are admirably adapted to the roasting of this class of ore. A large Wedge furnace, with seven hearths and a diameter of 22 ft. 6 in. is capable of roasting about 1¼ tons of this ore per hour, with unskilled labor, and gives a more satisfactory product than the smaller hand-rabbled furnaces. After roasting concentrates containing 45 per cent zinc, there is little difficulty in extracting as much as 95 per cent to 97 per cent of the zinc.

The successful electrolysis of zinc from sulphate solutions has not been an easy matter, and it is only within recent years that the difficult problem of depositing high-grade zinc has been satisfactorily accomplished on a commercial scale. The principal requisite is that the electrolyte shall be quite free from certain impurities. The methods by which freedom from these impurities is assured are now very well understood, and with experienced superintendence there is little difficulty in obtaining a high efficiency in that part of the process.

When certain underlying principles are recognized, the difficulty encountered in dealing with the filtration of the acid and slimy solutions also largely disappears, although it has been a very serious one to the uninitiated. In the dissolving of the zinc from the roasted ore there is nothing which any competent chemical engineer can not undertake, and any other operations connected with the electrolytic process are either of little or no difficulty, or are common to the retort process.

Electrolytic and Retort Processes Compared

In comparing the two processes, I do not think there is any more experience required in the electrolytic process than in retort smelting, and I shall not be surprised if within the next year or two the electrolytic is preferred as the simpler of the two. It is certain that, with the exception of the care of the electrical machinery, the commonest unskilled labor only is required to produce electrolytic zinc, whereas the retort process requires not only many physically strong, but also very skilled and highly paid men. The amount of labor necessary in the electrolytic process is, however, greater than that required in retort smelting, and also, as a general rule, the current to produce a ton of zinc costs much more than the gas or fuel to produce a ton of spelter. The electrolytic is as much dependetnt on cheap power as the retort process is on cheap fuel. The operation of roasting in Wedge Furnaces is, however, less costly than that in the special furnaces used for roasting the ore for retorting, in which nearly all the sulphur must be eliminated. The labor and power costs are in favor of the retort process.

The following costs for the treatment of run-of-mine ore of a complex nature are based on zinc at 5 cents per pound, St. Louis; lead at 5 cents per pound, and silver at 60 cents per ounce, assuming 88 per cent recovery of zinc. A typical composition of such an ore may be taken as zinc, 30 per cent; lead, 15 per cent, and silver, 12 oz. per ton. The average amount of current required to deposit a ton of zinc is less than 3000 kw.-hr., measured at the vats, when the process is well conducted and the solutions are pure and in good condition. To this must be added the ordinary motor, generator and other losses, and the current incidental to the operating of the factory. Four thousand kilowatt-hours have therefore been allowed per ton of zinc produced, although this amount is more than is necessary in practice:

PRODUCTION OF 25 TONS OF ZINC FROM 95 TONS OF ORE

		Per Ton Zinc	Per Lb. Zinc
100,000 kw.-hr. at ¼ cent	$250.00	$10.00	.50 cent
Labor at $3 and management	310.00	12.40	.62 cent
Fuel and supplies	60.00	2.40	.12 cent
Roasting, including labor and fuel	120.00	4.80	.24 cent
Insurance, maintenance and depreciation	250.00	10.00	.50 cent
	$990.00	$39.60	1.98 cent

Freight on the zinc naturally depends on the location of the electrolytic plant, and as this may be situated in a position difficult of access, we shall allow the ample average sum of $15.00 per ton of zinc:

Costs as above	$990.00	$39.60	1.98 cent
Freight on zinc	375.00	15.00	.75 cent
	$1,365.00	$54.60	2.73 cent
Balance, cost of ore and profit on zinc alone	1,135.00	45.40	2.27 cent
25 tons zinc at 5 cents	$2,500.00	$100.00	5.00 cent

In the case of an ore with the same content of lead and silver, but with 25 per cent zinc, the cost of production would be increased to the extent of 0.05 cent per pound of zinc. Complex ores of this composition are very plentiful, and are of no value unless treated in conjunction with the electrolytic process, for it is impossible to recover the lead and silver by smelting unless the zinc is partly removed. After the sulphur has been nearly eliminated by roasting, and the zinc has been extracted, the residue has only about one-half of the original weight, and the percentage content of lead and silver is doubled. The zinc that has been recovered not only pays for the cost of the ore but leaves a considerable profit, and the lead smelter has now a desirable smelting product containing nearly 30 per cent lead and 24 oz. silver per ton, which costs him nothing, as its cost has been credited to the zinc.

Smelting 48 tons residue, containing 30% lead and 1140 oz. silver, at $5.00	$240.00	
Freight on 13 tons lead and silver, at $10.00	130.00	
		$370.00
12.65 tons lead at 5 cents	$1,265.00	
1083 oz. silver at 60 cents	649.80	
	$1,914.80	
Deduct smelting and freight	370.00	
Profit on lead and silver	$1,544.80	

No allowance is made for the recovery of vitriol, as it is common to both processes.

Just as soon as the lead or copper smelter recognizes that a good extraction of zinc can be made from his zinc-lead or copper ores, we may expect him to erect an electrolytic zinc plant as an adjunct to his smelter, even though the price of zinc should fall so low that he can make no direct profit from the zinc, provided, of course, that he is favorably situated with regard to cheap power.

Influence and Effect of Manganese

There is another aspect of the question that has not yet received sufficient attention, which will have the effect of turning the balance in favor of the electrolytic process, should it be found that the retort process is still able to hold its own. In the electrolytic process the presence of manganese, in at least a small quantity, is an essential. Its principal function is to prevent sulphating or destruction of the anodes in the electrolytic vats, but it has also other valuable properties, chiefly in purifying the electrolyte. A large part of the manganese is deposited at the anode as hydrated manganese dioxide, concurrently with the deposition of zinc on the cathode. When the zinc ore contains much manganese, which is very frequently the case, the manganese dioxide recovered forms a very valuable by-product. No extra current, or rather, as far as the author's measurements have gone, only a negligible extra quantity of current is required to deposit the manganese. Unfortunately, the particular kind of roasting which is necessary to make the zinc soluble is not that which is most suited to the best recovery of manganese, and, therefore, when manganese is present in a zinc ore only part of it becomes soluble. There is no reason, however, why low-grade manganese ores should not be treated in a special furnace and the solution obtained by leaching added to the electrolyte and recovered as manganese dioxide in the electrolytic vats. The manganese dioxide is particularly well suited for use in dry batteries, quite apart from the demand that exists for manganese in the steel industry. A small quantity of the manganese dioxide deposited is used for the regeneration of manganese sulphate or sulphuric acid. The solution of the zinc in the roasted ore may be conducted in such a way that there is very little or no loss of acid, through the precipitation of basic sulphate of iron, but generally the iron and lead deplete the solution of more sulphate than that furnished by the sulphate of zinc, of which there is usually a small quantity in the roasted ore. Sulphurous acid from the roaster is brought into contact with the manganese dioxide, manganese sulphate is formed, from which dioxide is deposited in the electrolytic vats, and the sulphuric acid with which it was combined is in this way added to the circuit.

There is still further evidence that may be adduced in favor of the future supremacy of the electrolytic process. It is well known that with 5-cent spelter in pre-war time it was impossible for all except the most favorably situated retort smelters to make an adequate profit. The sulphuric acid recovered by some of the smelters enabled them to tide over the bad times, until the surplus stock of spelter had been disposed of. At that time it was very difficult to obtain zinc concentrates, for at the price of $40 per ton of 60 per cent concentrates the miner could not make sufficient profit. So many mines were shut down at that time that various writers attributed the cause to actual depletion of ore in the mines. It has, since that time, been proved that the real reason was that it was unprofitable to work at the prevailing prices. In Canada, and especially in British Columbia, there are vast quantities of complex ores and silver-zinc-lead ores, which it has not been possible hitherto to concentrate to much above 45 per cent. The retort process in Canada is impossible on account of the small supply of ore of sufficiently high grade. The concentrates are very impure and therefore do not command a high price. These concentrates are, however, very easily treated by the electrolytic process. It is imperative that the British Columbia miner shall concentrate his ore in order to separate the valuable silver-lead contents; the zinc concentrates are merely a by-product. The latter generally carry a considerable quantity of silver, of which 65 per cent to 70 per cent is paid for the United States smelters, after first deducting 6 oz. The price paid for the zinc is generally based on 5-cent zinc, $17.00 to $18.00 per ton being given for 40 per cent concentrates. After deducting duty, penalties and freight to the nearest United States zinc smelter, the Kootenay miner received only $5.00 to $7.00 per ton for his zinc concentrates. An electrolytic plant using these concentrates will prove to be a very serious competitor to the zinc smelter who can treat only high-grade concentrates. Even though he were able to treat 40 per cent concentrates as profitably as 60 per cent, the Missouri miner could not supply his 40 per cent concentrates to the smelter at much under $27.00 per ton. The electrolytic plant would thus have an advantage of about $20.00 per ton in the cost of ore, which much more than compensates for the higher cost of production in that process.

It must not be forgotten that when zinc-lead ore occurs in veins it must be concentrated in order to separate the more valuable lead contents, whether the miner is able to dispose of his zinc concentrates or not. Many of them actually run the zinc down the creeks because there is no market for it.

There are, of course, the considerations of cheap electric power, the improvement in flotation methods of concentration, distance from markets, and many others, which affect the future of these rival processes, but I think it must be conceded that it is at least very doubtful whether or not the retort process will be able to survive the competition of the electrolytic process within a few years.

Nelson, B. C.

None of the chromic iron ore mined on the Pacific coast has been concentrated before marketing otherwise than by rough sorting, and yet the grade of a large part of the ore suggests room for improvement in that direction, which could be effected to a large extent by more careful selection.

The Colloidal State of Matter in Its Relation to the Asphalt Industry*

By Clifford Richardson

Asphalt is found widely distributed in nature. It is a form of native bitumen. Bitumen occurs as gas, as naphtha, a very mobile liquid, as petroleum, existing as a liquid of various degrees of viscosity; as maltha, flowing but slowly at ordinary temperatures; in a more or less solid form known as asphalt, and as gilsonite, grahamite, ozokerite, etc.

The liquid forms of bitumen may be regarded as being derived from natural gas by condensation, and the solid bitumens from the liquid in a similar manner, the condensation being assisted by the surface action resulting from the contact of the gases or liquids with the "sands" in which they occur and with which they come in contact.[1]

Asphalt, as it is found in nature, is of very varied character, depending upon that of the particular petroleum in which it has originated. All petroleums do not form asphalt. For example, asphalt does not originate in paraffine petroleum. As petroleums are of a varied character and as those from different fields are sharply differentiated, where asphalt is formed from them, it is a material the character of which is dependent upon that of the oil in which it originates and upon the environment to which this oil has been exposed.

The term asphalt is also applied to the more or less solid residuals obtained industrially by the distillation of certain types of petroleum until the lighter components have been removed and a resulting residual pitch obtained, which, by its consistency and resemblance to the solid bitumens found in nature, is also known as asphalt. It is an artificial or manufactured product. Both the natural and artificial asphalts are used in the construction of pavements and road surfaces, although they are materials of quite different character.

THEORY OF AN ASPHALT PAVEMENT

The surface of an asphalt pavement consists of an aggregate of sand, the particles of which are of a well established and graded size, a filler or fine mineral dust and bitumen in the form of asphalt of proper consistency. From the point of view of the physical chemist it may be considered as a heterogeneous system of two components, or phases, one a solid (a mineral aggregate), and the other a liquid (in the form of bitumen).

A phase is a state or form of matter which is differentiated from some other by a distinct boundary between them. Two phases of this description may be regarded as making up a heterogeneous system. An asphalt surface may be regarded, therefore, as being a heterogeneous system of two components, liquid solid. Ostwald defines a phase as follows:

"By a phase is meant any homogeneous part of a system different from other parts of the system and separated from these by abrupt transitions."

In such a system, asphalt and mineral matter, asphalt must be considered as a liquid phase, since it is combined, while in a melted condition, with a mineral aggregate, a solid phase. Moreover asphalt is strictly a liquid even in a completed pavement, at ordinary temperatures, since it displays a slow flow under pressure at low temperatures. It is also recognized that the liquid component of such a system may differ in concentration at the surface of contact with the solid phase or boundary, where two such phases co-exist.

The mineral aggregate should present a large expanse of surface the development of which, as regards the unit volume of the solid mass which it represents, depends upon its degree of subdivision. Upon the proper relation between the surface thus developed and the volume of liquid, as represented by the asphalt, as well as upon the character and consistency of the latter, that of the asphalt road surface will depend.

IMPORTANCE OF SURFACE PHENOMENA

The importance of surface phenomena as they relate to stability in the construction of asphalt pavements and highway surfaces, has only been definitely recognized during the past few years, although attention was called to some features connected therewith as long ago as 1905 by the writer in a book "The Modern Asphalt Pavement." It was there demonstrated that the finer the mineral aggregate in a sheet asphalt pavement the greater the surface area of the particles which is to be coated with bitumen and the more satisfactory the pavement.

The great advance that has been made in the last ten years in the phenomena connected with the relation of solid surfaces and films of liquid, and especially of the relation of solids in a colloidal state to liquids with which they may be associated, makes it possible to apply the information which has been developed to an interpretation of the phenomena which are connected with the rational construction of bituminous road surfaces.

Energy is displayed by the contact of solid surfaces with liquid films. This is known as surface energy and is illustrated by a thin film of water placed between several pieces of glass, such as the glass slides ordinarily used in examining objects with the microscope, which makes it possible to lift them as one mass without their falling apart.

Where a solid is uniformly dispersed through a liquid this is known we have a physical system. In such a system energy is developed and this energy is proportional to the area of surface displayed by the solid and to the character of the liquid in which it is dispersed. The relation of the extent of surface displayed by the solid and the liquid covering it, plays an important part in the surface energy developed in any system consisting of subdivided mineral matter and bitumen in a more or less liquid form. It is of great interest in reaching a rational interpretation of the relations of these materials in the construction of asphalt pavements and roads.

SURFACE AREA

In 1905 it was shown by the writer, in the book which has been mentioned, that the increased extent of surface offered by a fine aggregate as compared with the coarser material, was enormous. One gram of sand, consisting of grains of uniform size which would pass a 10 mesh sieve and have a diameter of about 2 millimeters would consist of 212 particles having a surface area of 15

*A paper read before the St. Paul Engineering Society, in connection with the Minnesota Engineering Society, May 14, 1917.

[1] "The Nature and Origin of Petroleum and Asphalt," *Metallurgical and Chemical Engineering*, Jan. 1, 1917.

square centimeters. If the same weight of material were reduced to a size which would just pass a 200 mesh sieve having openings .08 mm. in diameter the number of particles would be increased to nearly one and a half million and the surface area would be 283 sq. cm. Proceeding still further and reducing the particles to a size of 0.0025 mm. they would number over forty-six billion and the surface area would be more than 9,000 square centimeters. The relation of the surface area of the material as a solid mass to that of the surface of the same material when subdivided, is known as specific surface. This increase in surface area and in specific surface with subdivision is well illustrated in the following data given by Ostwald:

INCREASE IN THE SURFACE OF A CUBE WITH PROGRESSIVE DECIMAL SUBDIVISION

Length of one edge			Number of cubes	Total surface	Specific surface
1	cm.		1	6 square cm.	6
1	mm.	$= 1 \times 10^{-1}$ cm.	10^3	60 square cm.	6.10^1
0.1	mm	$= 1 \times 10^{-2}$ cm.	10^6	600 square cm.	6.10^2
0.01	mm.	$= 1 \times 10^{-3}$ cm.	10^9	6000 square cm.	6.10^3
1.0	μ	$= 1 \times 10^{-4}$ cm.	10^{12}	6 square m.	6.10^4
0.1	μ	$= 1 \times 10^{-5}$ cm.	10^{15}	60 square m.	6.10^5
0.01	μ	$= 1 \times 10^{-6}$ cm.	10^{18}	600 square m.	6.10^6
1.0	$\mu\mu$	$= 1 \times 10^{-7}$ cm.	10^{21}	6000 square m.	6.10^7
0.1	$\mu\mu$	$= 1 \times 10^{-8}$ cm.	10^{24}	6 hectares	6.10^8
0.01	$\mu\mu$	$= 1 \times 10^{-9}$ cm.	10^{27}	60 hectares	6.10^9
0.001	$\mu\mu$	$= 1 \times 10^{-10}$ cm.	10^{30}	6 square km.	6.10^{10}

Particles of a size of 0.1 μ may be regarded as colloidal in relation to water and the development of surface by such subdivision is enormous and, of course, increases with further subdivision. Carried to the limit of ultra-microscopic visibility the surface area would reach 600 sq. m. and the specific surface 6×10^6.

Parts of the mineral aggregate of some asphalt surfaces reach the former state of subdivision. The surface energy developed thereby is very great and has an important bearing on the durability of an asphalt surface.

SURFACE TENSION

As stated by Ostwald, "Surface energy, as usually discussed, is made up of two components; a capacity factor as measured by the absolute surface, and an intensity factor as measured by surface tension. The latter type of surface energy endeavors to decrease the surface of a system if free energy is available."

In a sheet asphalt paving mixture the capacity factor is measured by the degree of fineness of the mineral aggregate, and the intensity factor by that of the character, that is to say, the surface tension, of the bitumen which is in use as a cementing material.

In the case of very fine aggregates the increase in the surface area, that is to say, the specific surface, as has been demonstrated, is enormous, as compared to that of a coarse one and would necessarily call for a larger amount of bitumen to cover it. This fact has an important bearing on asphalt surface mixtures, as prepared from different sands and with different amounts of filler. For example, the mineral aggregate of a coarse New York mixture laid in 1895 was found to have a surface area of about 44 square feet in one pound of material, whereas in a finer one of 1898 this was increased to over 60 square feet. This former was an unsatisfactory, and the latter a very satisfactory pavement. At that time attention was called to the fact that the more extended surface area of the finer aggregate would require a larger percentage of asphalt than the coarser and was more desirable on that account.

No further explanations or conclusions as to the nature of the relations involved were then drawn. With the further study, which has been so widely carried on in the last ten years, of the relation of surfaces and films and of the characteristics exhibited by matter in a highly dispersed or collodial state, we are to-day in a position to comprehend more fully and explain why this extended surface is a matter of importance in the construction of a satisfactory pavement, and why accepted methods of procedure, which have, hitherto, been founded more or less on an empirical basis alone and not upon certain definite physical laws associated therewith, have been successful. Surface phenomena are now recognized as being of great importance. For a thorough comprehension of the subject, reference must be made to the literature which is available.[2]

Investigations in connection with the relation of the surfaces of mineral aggregates of the type employed in the construction of asphalt pavements and of films of bitumen which serve to cement them together and in other engineering problems as well, have proved of interest not only as explaining the reasons for the successful results obtained in the construction of pavements of the type mentioned, as developed empirically during the last twenty years, but also, carrying these principles much further, in developing the possibility of producing other structural materials containing large percentages of mineral matter in a colloidal state, which are of value as presenting unusual physical characteristics and availability for particular uses.

EARLIER EXPERIENCE CONFIRMED

It was empirically shown as long ago as 1894 to 1896 by the study of successful surfaces that a satisfactory sheet asphalt pavement was one which contained, as part of the aggregate with which the bitumen is combined, a considerable percentage of filler, that is to say, of extremely fine mineral matter. This was attributed to the large extent of surface which such an aggregate offered to which bitumen might adhere, and in this respect was a current inference. At that time, however, the relation of surfaces and films and the principles of the chemistry of matter in a colloidal state had not been made clear, while to-day this subject has been more thoroughly elaborated and affords a means for the rational interpretation of the relation of surfaces and films, as applied to combinations of a mineral aggregate and bitumen, and of the enormous energy developed by the extensive surface presented by solid matter in the colloidal state. This now makes it possible to carry out work of this description on a scientific and rational basis.

COLLOIDAL CONDITIONS

One cannot properly speak of a substance, in itself, as a colloid. The word denotes, rather, a state of matter dependent on the relation of one phase to another, and is one in which all material can exist. It relates, as regards solids and liquids, to the state of subdivision of the former and its dispersion through the latter.

[2] "An Introduction to the Physics and Chemistry of Colloids," by Emil Hatschek, 1916. P. Blakiston's Son & Co., Philadelphia.
"The Chemistry of Colloids," by W. W. Taylor, 1915. Longmans, Green & Co., New York.
"Die Welt der vernachlassigten Dimensionen," by Wolfgang Ostwald, Theodor Steinkopff, Dresden, Germany.
"Handbook of Colloid Chemistry," by Ostwald, translated by Fischer, 1909. P. Blakiston's Son & Co., Philadelphia.
"The Physical Properties of Colloidal Solutions," by E. F. Burton, 1916. Longmans, Green & Co., New York.
"The Technical Control of Colloidal Matter in Clay," Technologic Paper No. 23. Bureau of Standards, Washington, D. C.

Whether a solid is in a colloidal state or not depends not only on its state of subdivision but upon the viscosity of the liquid or continuous phase or medium in which it is dispersed. A substance, which owing to its degree of subdivision would settle rapidly out of water a mobile aqueous phase, may exist in a colloidal state as regards a very viscous bitumen, such as the heavy residuals of petroleum, which flow but slowly at ordinary temperatures. An example of the latter will be found in Trinidad asphalt, which contains a large amount of fine mineral matter, 25 per cent, which, all of it, exists in a colloidal state as regards the bitumen, although some of it is fine sand, of a size which will be retained on a screen of 100 meshes to the lineal inch. This comparatively coarse material is in a state known as colloidal, because the continuous phase in which it is dispersed may be regarded as a highly viscous liquid.

Clay, as it occurs in nature, is of a very varied character. It is in deposits of different origin, in a more or less colloidal state as regards the water with which it is associated, no doubt depending upon the manner in which it has been formed, whether it is residual or sedimentary, the latter being usually the more colloidal.

It is recognized that clay can be readily diffused in water. Dry clay cannot be readily diffused through the denser forms of bitumen because the individual particles of the clay adhere to one another, and because they are covered with an absorbed film of air or water which prevents its being coated with bitumen. For these reasons dry clay cannot be dispersed uniformly through such a viscous medium as a dense bitumen. If, however, the clay is originally thoroughly dispersed in water as a continuous phase it can then be emulsified with any bitumen which is sufficiently liquid at temperatures below that of boiling water to make it possible. On the removal of the aqueous phase from the emulsion by heating, the highly dispersed clay will then enter into the bituminous phase without difficulty and will then be dispersed therein in a colloidal state or as a colloidal solution of clay in bitumen.

COLLOIDAL BITUMENS

Clay in a colloidal state can also be introduced in the same way with greater facility into the more liquid types of asphaltic bitumen. The amount, introduced in this way, may reach with certain oils as much as 60 per cent. Such a material may be used for fluxing the harder bitumens for the purpose of introducing colloidal clay into them in a simpler manner than by attempting to do so directly. With a sufficient amount of clay in a colloidal state in the flux, the latter has such stability that it can be shipped without packages. Combinations of asphalt and colloidal clay may be obtained in this way which present some extraordinary and valuable characteristics from an industrial point of view.

The native asphalts of a highly viscous nature, and the heavy residuals derived from asphaltic petroleum, possess, however, very different capacities for maintaining clay in suspension in a colloidal state, and this capacity differentiates them in a striking manner, demonstrating the difference in character of the components of which these asphalts are made up. This is illustrated by the determinations of what may be called the capacity of various asphalts to maintain colloidal clay in suspension under different conditions. Colloidal clay was introduced into a number of solid residuals of various types of petroleum, by the addition of enough aqueous clay paste to result in a material which, after removal of the water, should consist of 67 per cent. bitumen and 33 per cent clay. These materials were maintained in a melted condition, at a temperature of 325 deg. F. in tubes for 24 hours. The sedimentation which, with the reduction of the viscosity of the continuous phase, went on in that period, appears from the following figures:

Colloidal Capacity of Various Types of Bitumen

Mixtures of 67 Per Cent Bitumen and 33 Per Cent Clay Introduced Wet, Maintained at 325 Deg. F. for Twenty-four Hours

Source	Penetration	Per Cent Colloidal Matter Before Heating	Per Cent Colloidal Matter After Heating	Per Cent Sedimentation
Trinidad Residual	50	33.5	33.7	0.0
Bababui Residual	48	32.4	30.1	7.0
Mexican Residual	50	33.3	27.2	18.3
California Residual	50	31.8	23.8	25.2
Mid-Continental Semi-Paraffine Residual	51	33.8	21.7	35.8

The colloidal capacity thus determined is a function of the character of the particular bitumen and also of its viscosity at the temperature concerned. The striking feature is that the residual asphalt prepared from semi-paraffine petroleum of the Mid-continental field deposited 35.8 per cent of the clay at high temperature, showing the small capacity of paraffine oils to maintain clay in suspension in a colloidal state. At the other extreme a Trinidad residual deposits nothing under the same circumstances. A Bababui residual, prepared from a Venezuelan petroleum, which is heavier than water when it emerges from the well, deposits but 7 per cent, a Mexican residual 18.3 per cent, while the California residual deposits an increased amount.

As the film of bitumen which covers the mineral aggregate of a sheet asphalt pavement is formed at the temperature given, these data may convey some idea as to the capacity of the different materials for coating the grains of this aggregate, but too much dependence must not be placed upon them as there are so many other controlling features in relation to the character of the films. It is striking, however, that the Trinidad residual is so thoroughly differentiated from all the others, thus confirming the opinion, based upon service tests, in regard to the unique character of this material.

If the same mixtures of bitumen and colloidal clay are examined in a 10 per cent solution in carbon-disulphide, which has been submitted to centrifugal action, the results are equally striking.

The Trinidad residual again has the greater colloidal capacity, while the Mexican residual, under the conditions, shows a decided reduction in this respect, while the semi-paraffine, Mid-continental material, again has the smallest capacity. This capacity of different bitu-

Colloidal Capacity of Various Types of Bitumen

In Mixtures of 67 Per Cent Bitumen and 33 Per Cent Colloidal Clay

Sedimentation of 10 Per Cent Solutions on Centrifuging. In Carbon-Disulphide

Source	Per Cent Remaining in Suspension
Trinidad Residual	2.23
Bababui Residual	1.91
California Residual	1.89
Mexican Residual	0.94
Mid-Continental Semi-Paraffine Residual	0.54

mens of the same consistency for maintaining clay in a colloidal state, under different conditions, is strong evidence of the fact that asphalt from various sources is of a different character.

Trinidad lake asphalt after the removal of the water by heating, that is to say, in a refined condition, contains about 35 per cent of anhydrous mineral matter, as determined by ignition, all of which must have been in a colloidal state, since the amount found in all parts of the deposit is the same and this uniformity can only be accounted for on this supposition. If this asphalt is dissolved in carbon-disulphide or benzol to form a solution of varying degrees of concentration and centrifuged to remove the mineral matter which is too coarse to remain in the colloidal state, in a liquid of the viscosity corresponding to the concentration, the resulting solutions will be found to contain a percentage of colloidal matter varying with the concentration and viscosity. The data which have been obtained as the results of experiments along these lines are as follows:

CHARACTERIZATION OF SOLUTIONS OF TRINIDAD ASPHALT

Per Cent Concentration	Specific Gravity	Increase for 1 Per Cent	Absolute Viscosity	Difference for 1 Per Cent
Benzol	.876	....	0.00652	.....
1 per cent T. R. A.	.877	.0010	0.00654	0.00002
2 per cent T. R. A.	.879	.0020	.000687	0.00033
5 per cent T. R. A.	.883	.0013	0.00759	0.00024
10 per cent T. R. A.	.889	.0012	0.00961	0.00040
20 per cent T. R. A.	.911	.0022	0.01629	0.00067
30 per cent T. R. A.	.930	.0019	0.04198	0.00257
40 per cent T. R. A.	.957	.0027	0.09477	0.00521
50 per cent T. R. A.	1.012	.0055	0.31800	0.02240
100 per cent T. R. A.	1.400	.0076	.....	.....

CHARACTERIZATION OF SOLUTIONS OF TRINIDAD ASPHALT

Per Cent Concentration	Refined—Per Cent Colloidal Matter	Refined—Amount for 1 Per Cent
1 per cent	2.54	2.54
2 per cent	2.01	1.00
5 per cent	2.09	.42
10 per cent	2.73	.27
20 per cent	3.13	.16
30 per cent	4.19	.14
40 per cent	6.51	.16
50 per cent	10.69	.21
100 per cent	35.40	.35

Cn Benzol.

The percentage of clay in a colloidal state varies but slightly for concentration of from 1 to 10 per cent, but increases gradually above this. These changes are most strikingly brought out if the increase is calculated for 1 per cent for the different intervals, as shown in the tables. The amount decreases gradually per unit of bitumen until the concentration of 40 per cent is reached, when it again increases up to 100 per cent, which is not, however, a maximum.

It appears from these figures that this result might be due to irregularities in changes in the viscosity of the solutions under examination with concentration, but determinations have shown that this is not the case, since the absolute viscosity increases in a perfectly regular way. The same may be said in regard to the increase of the specific gravity of the solution. On plotting these data it appears that the curves show that the changes in specific gravity are represented by a straight line, or approximately so, the curve for absolute viscosity by a paraboloid, and that for suspended solids by a slightly irregular paraboloid. It appears then that the increase in the amount of clay in a colloidal state is gradual for a lower but sharp for the higher concentrations.

The peculiar relations of colloidal clay and bitumen as demonstrated by the preceding data are of great interest. They serve to demonstrate the importance of the relations of surfaces and films and of the peculiar role played by matter in a colloidal state in connection with combinations of bitumen and mineral matter as employed in paving and road construction. It can be readily seen that the relations of water as a continuous phase and mineral matter in various degrees of dispersion can be interpreted along similar lines and are of importance to the engineer in many connections. It is a subject which, in this direction, has received only superficial attention up to the present time.

New York City.

Dezincification of Brass Pipe

By Edward B. Story

Some ten or twelve years ago brass pipe began to be used commercially for water systems. The idea, prevalent to that time, was that such an installation should give a much longer life than steel or even iron pipe. This idea was based entirely on the one fundamental fact that brass seemed to stand up well from a corrosion standpoint. However, after a few years of service, and indeed in much shorter time than was anticipated, brass pipe began to show evidence of deterioration.

The tough and ductile brass seems to metamorphose itself into a very weak and brittle form, so that comparatively slight stresses due to shock, vibration, expansion or contraction, which the normal brass would have no difficulty to withstand, are now sufficient to cause cracks and occasionally complete failure. The failure usually occurs at the joints, presumably so because of the thinner wall section and threading.

Aggravations reach a climax when an attempt is made to remove a failed or leaky joint, for the torsional stress attending the uncoupling or coupling is again sufficient to cause a failure in some other length or joint in the installation. Consequently, one failure results from an endeavor to repair a previous one, and it is difficult to estimate just how many lengths will have to be ultimately replaced before the repair is completed. Thus aside from the labor and inconvenience, the cost of the new material installed results in quite an item of expense.

Brass pipe that has become brittle and weak is invariably accompanied by a grayish white, seemingly carbonaceous deposit, appearing profusely on the interior walls and frequently in patches on the exterior of the pipe. When the brass is scraped clean of this deposit, the underlying metal appears much redder in color than the surrounding brass, and in fact to such a marked degree that to all outward appearances it resembles copper very closely. This led to the belief that perhaps the brass undergoes some decomposition reac-

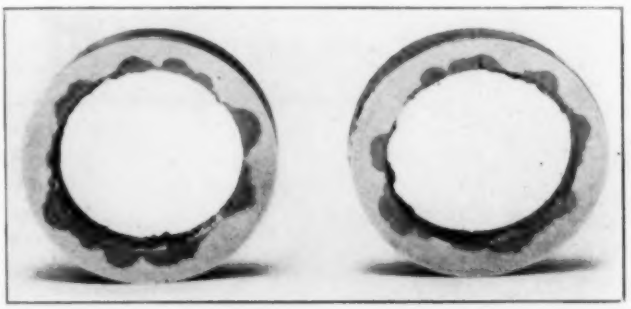

FIG. 1—"DEZINCIFIED" BRASS PIPE. DARK AREAS ARE BRASS DEPLETED IN ZINC. MAGNIFICATION 3 DIAMETERS

tion in which there is a depletion in zinc, or what might be better termed "dezincification." Analysis of the carbonaceous deposits indicates that the zinc content is relatively high, only traces of copper being present, which of course substantiates, to some extent, the conjecture that the brass has been dezincified.

In order to examine more clearly these apparently dezincified regions, sections were sawed from the affected pipe, and after grinding and polishing the areas showed themselves quite clearly. Heat tinting further developed the contrasted areas. Figure 1 shows two such sections of the pipe at a magnification of three or four times. The areas are easily discernible by their darker color, and appear as an inside border which projects quite deeply into the body metal at places. Occasionally the action starts on the interior surface of the pipe and, continuing, completely dezincifies the entire wall section, emerging at the exterior; or, action starts both on the interior and exterior, meeting in the center of the wall section.

As stated above, these cases are uncommon, probably because the pipe in general cannot remain in service long enough for such conditions to become evident.

The dezincified portions do not adhere strongly to the other metal, for only a slight pressure with a tool is sufficient to dislodge them. The ease with which they can be removed, and the character and appearance of the cleavage, give evidence that they are the result of a depositing action.

Analysis of these dislodged dezincified particles gives the following composition:

(Sample)	Original Brass A. Per Cent.	Original Brass B. Per Cent.	Dezincified Brass A. Per Cent.	Dezincified Brass B. Per Cent.
Copper	58.40	60.10	85.70	94.50
Zinc	40.60	39.30	13.97	4.49
Lead	0.37	0.21	Trace	0.06
Tin	Trace	Trace	Trace	Trace
Other impurities	Not determined		Not determined	

This analysis gives substantial evidence that the brass has been dezincified in segregated zones.

Microscopical Examination

The specimen after polishing was etched with hydrogen peroxide in presence of ammonia. Figs. 2, 3, 4 and 5 are microphotographs taken at 100 diameters. Although the areas high in copper appear in sharp contrast to the normal brass areas when viewed with the naked eye as shown in Fig. 1, yet the microscope reveals that there is no sharp line of demarcation, but that the dezincified portions high in copper are separated from the normal brass by a region that shows incomplete dezincification in which the depletion in zinc is less the closer we get to the brass.

In Fig. 2 the upper dark portion is the normal brass which shades off in the central part to a less dense structure which is the partly dezincified brass, and the lower dark colored area shows the copper which has been practically depleted of zinc. The white areas and also the white structureless band are copper regions, and are the same as the pure copper showing dark at the bottom. The white copper areas in the partly dezincified zone and also the white band not assuming a structure, are due to the fact that pure copper is negative with respect to brass, and in the range of incomplete dezincification there still remains some unchanged brass which protects the pure copper from action by the etching agent. This protection is similar to that given iron and steel by galvanizing. However, when the pure copper areas are far enough distant from the unchanged brass, sufficient protection is not afforded, and we then have an attack on the copper by the etching agent, with a resulting structure revealed as in the lower portion of the microphotograph.

In Fig. 3 the dezincification is revealed as taking place from the two sides, evidenced by the copper appearing

FIG. 2—BRASS UNDERGOING "DEZINCIFICATION." MAGNIFICATION 100 DIAMETERS

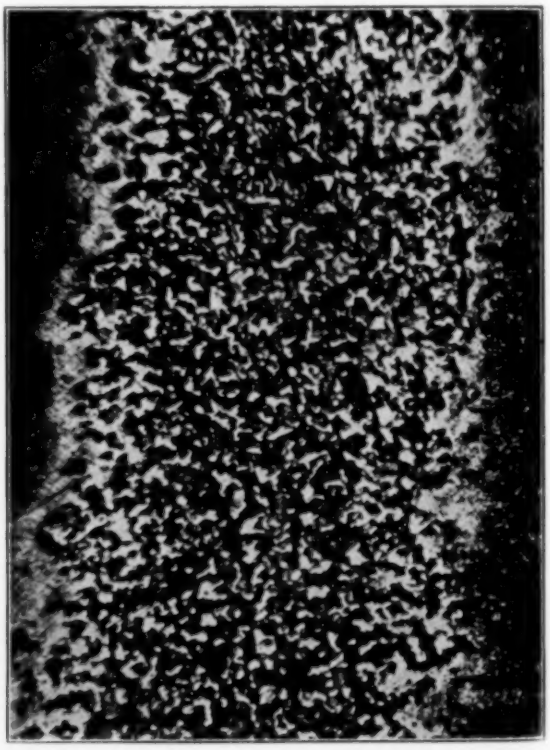

FIG. 3—BRASS UNDERGOING "DEZINCIFICATION." MAGNIFICATION 100 DIAMETERS

FIG. 4—PARTLY "DEZINCIFIED" BRASS

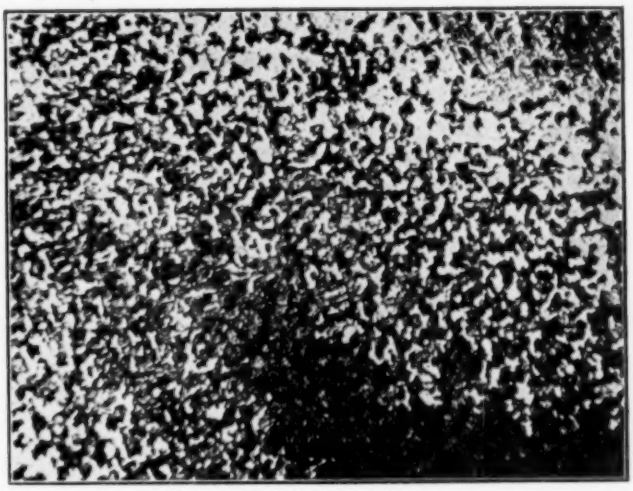

FIG. 5—PARTLY "DEZINCIFIED" BRASS

as dark bands on either edge of the central portion, which shows incomplete dezincification. This photograph shows a case previously alluded to, in which the action had started on the exterior as well as the interior and the pipe had been dezincified entirely through the wall except for the slight portion shown in the central part of the photograph. The white structureless copper bands are again showing where the remaining grass has exercised sufficient protection against the action of the etching agent.

Figs. 4 and 5 both depict regions where the brass is undergoing dezincification. They show clearly that the regions depleted in zinc are not sharply defined from the normal brass, but that there are intermediate regions where the action has partly completed itself, leading one to believe that the action is a rather progressive one. As in the previous photographs, the dark areas are the brass, the white ones the copper.

Theory and Mechanism of Dezincification

Brass is primarily an alloy of copper and zinc, the commercial forms containing small quantities of contaminants such as lead, tin and other impurities. The range of composition is very wide, and the cheaper yellow or white brasses may contain as little as 2.5 per cent copper. The better brasses, the red ones, usually contain 60 per cent or more of copper.

Although the brasses probably have been investigated more thoroughly than any other non-ferrous alloy, yet, owing to their very complex nature, the exact constitution of brass is still to be definitely settled. From the more recent researches authorities now seem generally to agree that brass is in the group forming chemical compounds, with probably some mixed crystals. In the light then of this generally accepted theory of the constitution of brass (*i. e.*, forming chemical compounds of copper and zinc), it is evident that any solution or chemical reaction does not affect either the copper or zinc individually, but the copper and zinc are both affected in the ration of the amounts which form the chemical compound. The microphotographs bear this out clearly, for if the zinc were leached out with no action on the copper, then the pure remaining copper areas should show a honeycombed structure, which is not the case.

There are a number of factors that can cause a solution of the brass: a strained condition of the brass, impurities, segregation, or the presence of two or more chemical compounds, any one of which would tend to produce zones of varying electro-chemical characteristics, and which in the presence of water acting as an electrolyte would cause reactions to be set up whereby the brass goes into solution. When in solution, the copper and zinc are no longer in an atomic or molecular state, but have been ionized, the copper ions being electronegative, and the zinc ions electropositive with respect to the existing unaffected brass. This condition cannot exist, and the electronegative ions are discharged on the surface of the brass with resulting deposits of metallic copper. Of course, the solution of the brass and the deposition of the pure copper is practically an instantaneous action and restricted to the localized spot where solution was originally effected. When once a mere trace of copper has been deposited, we have ideal conditions for further solution, for the brass is now electropositive to the newly deposited copper with the result that more brass goes into solution with, of course, deposits of corresponding masses of copper.

Thus it is evident that only the slightest cause, such as segregation, strain and other previously mentioned reasons which may seem remote and of little consequence, are sufficient to produce the nucleus of pure deposited copper and start the endless action that will ultimately result in the failure of the brass pipe.

Research Department,
A. M. Byers Co.,
Pittsburgh, Pa.

The greatly increased trade in steel and the consequently larger demand for ferrochrome have stimulated the search for chromite in the United States, as is shown by the fourteenfold increase in production in 1916 as compared with 1915. There were four producing States in 1916. On the Atlantic coast and in Wyoming there was only a small production, but in the Pacific Coast States, especially California, the advance in the output has been remarkable. Maryland and Wyoming had one producer in each State. Oregon, with about half a dozen producers in three counties, had a production which, combined with that of Maryland and Wyoming, amounted to 3,277 tons, valued at $43,306; California produced 43,758 tons.

The United Eastern Mill*

By Otto Wartenweiler

The character of the ore for which this mill was erected is similar to that of other mines in the Oatman, Ariz., district, where milling plants have been in successful operation for several years.

The ore consists of a mixture of calcite and quartz in about equal quantities with some decomposed andesite, while the average value of mill head was calculated to be $20 plus in gold, no silver being present. The tonnage to be treated at the start was fixed at 200 tons, but it was considered advisable to arrange facilities for increasing the capacity to 400 tons. While it is best in some cases to adopt a distinct independent unit system where future enlargement is contemplated, in this instance the plans worked out differently. Summarized, the treatment adopted consists of coarse crushing, coarse grinding, fine grinding and cyanidation.

For coarse crushing the selection of the No. 6 size gyratory crusher was governed not so much by its capacity as by the size of the feed openings to properly receive the run-of-mine material, which was too coarse for a No. 5 crusher.

To accomplish the coarse grinding to best advantage, a careful comparison was made between the modern steel ball-mill—the last word in crushing and grinding—and one of its older, and at that time better established, competitors, the rolls. The following conclusion was reached: While it is possible that for the sized plant under consideration the cost of operating rolls might be a little cheaper, it is preferable to use ball-mills because a simpler arrangement is possible, and because the handling of ball-mills is preferred by the operator.

A marked departure was introduced for fine grinding. Instead of the long type of tube-mill, using pebbles, a mill of similar design was selected, but of much shorter length, using small cast-steel balls as grinding medium.

For cyanidation, the Dorr continuous countercurrent process was adopted, its advantages for these conditions having been clearly demonstrated in one of the local mills.

Pumping Plant

The water supply is taken from a well about 4 miles from the mill. The well pit was enlarged and a 2-in. centrifugal booster pump set down about 20 ft. below surface, pumping into a tank from whence a 4 by 8-in. Dow triplex pump driven by a 30-hp. motor supplies a 4-in. pipe line at 400 lb. per square inch pressure and 75 gal. per minute. Immediately at the pump discharge a water relief valve set at 500 lb. per square inch is installed, and beyond this is a standpipe or air cushion made of 10-in. pipe and fittings and connected to a hydraulic air-pump. Beyond the standpipe and outside of the pump house is a check valve to protect the house and contents in case of a break below the valve. The pipe line goes over rough country and lies on the surface except where it crosses Silver Creek, at which place it is buried about 3 ft. for a length of about 300 ft. It has expansion joints made up of four ells and three short pieces of pipe about every 500 ft. The tops of all important vertical bends have air-outlet valves and the bottoms have drain cocks. The four-ell expansion joints aid materially in laying the pipe over irregular country, while the resistance is small because of the low velocity of the water. The pipe line ends at two water-storage tanks having a capacity of 75,000 gal. each and located about 75 ft. above the surface plant. From here a 4-in. gravity line serves the mill and mine.

*Excerpt of a paper to be presented at the New York meeting of the Amer. Inst. of Min. Eng., Feb., 1918.

Cost of Construction of Milling Plant and Miscellaneous Buildings as at January 31, 1917

Account Title	Labor	Material	Power	Miscellaneous	Total
Mill:					
Mill proper	$32,211.08	$90,328.04	$135.81	$10,864.16	$133,539.09
Crushing plant	2,456.50	9,504.81	....	14.06	11,975.37
Coarse ore bins	953.97	962.30	....	.....	1,916.27
Refinery	2,093.52	3,695.61	....	.....	5,789.13
Miscellaneous:					
Machine shop	815.02	7,407.92	....	.....	8,222.94
Storehouse	824.74	2,266.60	....	.....	3,091.34
Transformer house	517.64	4,109.53	....	.....	4,627.17
Assay office	457.90	1,711.77	....	.....	2,169.67
Inclined tramway	224.02	880.84	....	.....	1,104.86
Water system	2,197.34	18,780.23	....	3,321.31	24,298.88

Table I—Main Mill Construction

	Labor	Material	Power	Miscellaneous	Total
Excavation	$10,897.04	$2,203.52	....	.....	$13,100.56
Concrete	5,473.74	4,411.18	$21.54	$945.85	10,852.31
Machinery, f. o. b. Oatman[1]	.....	57,487.02	....	.....	57,487.02
Machinery, erection	4,022.18	862.36	114.27	390.75	5,389.56
Building lumber	.....	7,411.87	....	.....	7,411.87
Lumber framing and erection	5,205.89	538.02	....	420.96	6,164.87
Building covering in place	821.50	2,302.77	....	.....	3,124.27
Doors and windows in place	183.06	75.16	....	.....	258.22
Wood tanks, f.o.b. Oatman	.....	7,811.06	....	.....	7,811.06
Wood tanks, erection	939.27	122.80	....	3.62	1,065.69
Piping, f.o.b. Oatman	.....	2,864.93	....	.....	2,864.93
Piping, erection	1,329.63	.....	....	.....	1,329.63
Electric wiring, f.o.b. Oatman	.....	2,906.89	....	.....	2,906.89
Electric wiring, erection	1,483.04	.....	....	.....	1,483.04
Belting in place	18.06	722.22	....	.....	740.28
Launder lumber	.....	71.57	....	.....	71.57
Launders, erection	412.14	22.87	....	.....	435.01
Engineering, Los Angeles Office	.....	.....	....	9,050.99	9,050.99
Engineering, field	749.05	182.80	....	51.99	983.84
Tailings dump and fences	330.87	24.89	....	.....	355.76
Furniture and fixtures	6.50	51.50	....	.....	58.00
Painting	221.87	132.30	....	.....	354.17
Small tools and equipment	117.24	122.31	....	.....	239.55
Total mill construction	$32,211.08	$90,328.04	$135.81	$10,864.16	$133,539.09

[1]See note under refinery, Table 4.

Table 2—Crushing Plant Construction

	Labor	Material	Miscellaneous	Total
Excavation	$502.00	$333.25	.....	$835.25
Concrete	251.10	351.68	.....	602.78
Machinery, f.o.b. Oatman	.....	6,323.73	.....	6,323.73
Machinery, erection	671.20	103.27	.....	774.47
Building lumber	.....	1,208.48	$14.06	1,222.54
Lumber framing and erection	704.20	77.82	.....	782.02
Building covering in place	4.00	325.86	.....	329.86
Doors and windows in place	.....	19.74	.....	19.74
Electric wiring, f.o.b. Oatman	.....	184.46	.....	184.46
Electric wiring, erection	118.53	.....	.....	118.53
Belting in place	.....	586.82	.....	586.82
Engineering, field	124.85	.....	.....	124.85
Painting	80.62	29.18	.....	109.80
Total crushing plant construction	$2,456.50	$9,504.81	$14.06	$11,975.37

[1]Credit.

TABLE 3—COARSE ORE BINS

	Labor	Material	Total
Excavation	$44.50	$144.75	$189.25
Concrete	520.96	61.88	582.84
Building lumber	.....	741.63	741.63
Lumber framing and erection	368.51	14.04	382.55
Engineering, field	20.00	.....	20.00
Total coarse ore bins	$953.97	$962.30	$1,916.27

Mill Site

The mill site was chosen on a hill having its apex near the strike of the United Eastern vein, the top of the hill being suitable for the surface plant and the side of the hill having the necessary slope for the grinding departments. A level site for the cyanide plant was obtained by excavation, and the top of the hill was leveled off for the surface plant. It was of considerable importance to have the mill tailings discharge at as high an elevation as possible, on account of the topography of the country required for tailing shortage, and therefore the mill building was pushed further up the hill than it otherwise would have been.

Crushing Plant

The primary crushing department consists of a No. 6 Telsmith crusher belted to a 50-hp. motor and is automatically fed by a 42-in. steel apron feeder moving 1½ ft. per minute and discharging 25 tons per hour. The ore is crushed to 3 in. and drops onto an 18-in. wide 20 deg. inclined belt conveyor passing over a Merrick weightometer and is discharged into a 24 by 24-ft. circular wooden tank bin, having its discharge gate in the center of the bottom. This represents the ideal case for loading and discharge, giving the maximum capacity for the size of the bin; less expensive than a rectangular bin and more efficient. The bottom of the bin is built of 4-in. material while the staves consist of 3-in. material, all Oregon pine lumber. The hoisting and primary crushing is intended to be done in one shift.

Mill

The coarse-grinding department consists of two No. 6½ Marcy mills each direct-connected to 100-hp.

TABLE 4—REFINERY

	Labor	Material	Total
Plastering	$18.62	.....	$18.62
Excavation	149.75	.....	149.75
Concrete	808.06	$498.22	1,306.28
Machinery, f. o. b. Catman	.....	1,439.14	1,439.14
Machinery, erection	213.24	90.73	303.97
Building lumber, f.o.b. Catman	.....	68.06	68.06
Lumber framing and erection	358.20	5.50	363.70
Building covering in place, includes steel trusses	62.00	1,007.22	1,069.22
Doors and windows in place	141.75	147.76	289.51
Tank, f.o.b. Catman	.....	53.35	53.35
Piping, f.o.b. Catman	.....	219.14	219.14
Piping, erection	9.56	.....	9.56
Electric wiring, f.o.b. Catman	.....	31.75	31.75
Electric wiring, erection	46.62	.....	46.62
Engineering, field	63.10	.....	63.10
Furniture and fixtures	3.37	109.58	112.95
Painting	68.13	5.96	74.09
Concrete blocks	151.12	12.00	163.12
Small tools and equipment	.....	7.20	7.20
Total Refinery	$2,093.52	$3,695.61	$5,789.13

Precipitation presses were not charged in this account. The Merrill contract did not specify separate prices, and two precipitation presses and one clarification press, and zinc feeder, were charged to mill. The charge was:

Three presses and zinc feeder	$8,450.00
Freight	439.20
Hauling	126.00
Total	$9,015.20

TABLE 5—MACHINE SHOP

	Labor	Material	Total
Excavation	$25.50	.....	$25.50
Concrete	.....	$35.56	35.56
Machinery, f.o.b. Catman	.....	6,473.94	6,473.94
Machinery, erection	292.69	37.10	329.79
Building lumber	.....	483.05	483.05
Lumber framing and erection	362.85	48.65	411.50
Building covering in place	.....	159.17	159.17
Doors and windows in place	18.33	68.47	86.80
Electric wiring, f.o.b. Catman	.....	44.34	44.34
Electric wiring, erection	46.68	.....	46.68
Engineering, field	13.10	.....	13.10
Furniture and fixtures	9.00	.....	9.00
Painting	46.87	29.76	76.63
Small bench tools	.....	27.88	27.88
Total machine shop	$815.02	$7,407.92	$8,222.94

Allis-Chalmers motors through flexible couplings and herringbone gears; automatically fed at the rate of 8½ tons per hour by an 18-in. steel apron conveyor traveling at the rate of 1½ ft. per minute, taking the crushed ore from the bottom of the circular tank bin, its discharge being split for each ball-mill. Each Marcy mill operates in closed circuit with a duplex Callow screen, the oversize of which is returned to the Marcy mill by an 18-in. belt and bucket elevator and the undersize (—30-mesh) goes to a combined distributer and sampler. The feed to the Callow screens is arranged so that either Marcy mill may work with either screen. Before deciding on Callow screens for this separation, Dorr classifiers were considered, the idea being that they were more economical in operation, and that the special elevator for returning the +30-mesh might be eliminated, but since up to that time a Dorr classifier had not been proved to be satisfactory on material coarser than 48-mesh, preference was given to the Callow screen.

The work intended for one ball-mill operating in closed circuit as described consists of grinding 200 tons of ore that has passed a 3-in. ring to a product passing a 30-mesh screen per 24 hours, the mill being loaded with from 7000 to 8000 lb. of 5-in. balls. While one ball-mill apparently would have been of sufficient capacity for the initial mill tonnage required, it was deemed advisable to install a second machine, having in mind the possible increase in tonnage which soon may have to be met, and also realizing the necessity of a standby machine to secure continuous operation of the plant. The Marcy mills are fitted with specially designed feed scoops, so that the wet rejects from the Callow screens are taken in at the periphery while the dry ore from the feeder goes directly into the center of the scoop.

The fine-grinding department is composed of three Allis-Chalmers tube mills, 5 ft. in diameter by 6 ft. long, each direct-connected to 75-hp. motors through flexible couplings and herringbone gears, operating in closed circuit with a Dorr duplex classifier. The feed comes from the combined distributer and sampler to

TABLE 6—STOREHOUSE CONSTRUCTION

	Labor	Material	Total
Excavation	$199.48	$1.40	$200.88
Concrete	.....	13.31	13.31
Building lumber	.....	1,389.64	1,389.64
Lumber framing and erection	456.11	67.69	523.80
Building covering in place	.....	223.89	223.89
Doors and windows in place	85.75	120.96	206.71
Electric wiring, f.o.b. Catman	.....	20.42	20.42
Electric wiring, erection	19.25	.....	19.25
Engineering, field	6.65	.....	6.65
Furniture and fixtures	30.00	429.29	459.29
Painting	27.50	.....	27.50
Total storehouse construction	$824.74	$2,266.60	$3,091.34

TABLE 7—TRANSFORMER HOUSE AND EQUIPMENT

	Labor	Material	Total
Excavation	$148.05	.....	$148.05
Concrete	2.00	.....	2.00
Machinery, f.o.b. Catman	.....	$3,327.77	3,327.77
Machinery, erection	51.12	22.40	73.52
Building lumber	.....	174.31	174.31
Lumber framing and erection	40.25	.....	40.25
Building covering in place	7.50	92.69	100.19
Electric wiring, f.o.b. Catman	.....	475.83	475.83
Electric wiring, erection	181.21	.....	181.21
Engineering, field	60.00	.....	60.00
Painting	27.50	16.53	44.03
Total transformer house and equipment	$517.64	$4,109.53	$4,627.17

TABLE 9—INCLINED TRAMWAY

	Labor	Material	Total
Excavation	$127.75	$0.57	$128.32
Concrete	12.06	8.52	20.58
Machinery, f.o.b. Catman	.....	806.37	806.37
Machinery, erection	37.77	63.69	101.46
Lumber framing and erection	13.37	.....	13.37
Electric wiring, f.o.b. Catman	.....	1.41	1.41
Electric wiring, erection	26.62	.....	26.62
Engineering, field	6.45	.....	6.45
Painting	.....	0.28	0.28
Total inclined tramway	$224.02	$880.84	$1,104.86

the Dorr classifier, the coarse discharge of which is taken into the tube mill by a 42-in. scoop. The Dorr classifiers overflow into a launder to a Callow 8-ft. sloughing-off tank where additional settling is expected to take place. These tube mills, or ball-peb mills as they are designated by the manufacturer, are built to use ⅞-in. diameter cast-steel balls instead of pebbles as grinding medium. Like the ball mills, they are lined with steel. The work intended for one ball-peb mill operating in closed circuit consists of grinding 133 tons of 30-mesh feed so that 85 per cent of the discharge will pass through a 200-mesh screen, using a charge of 13,000 lb. of ⅞-in. diameter ball pebs. It will be noticed that in the fine-grinding department the same idea referring to future increase in tonnage as well as standbys again was observed. In adopting these extremely short tube mills for fine grinding preparatory to cyanidation, considerable hesitancy was displayed, since excepting some information on dry work in cement plants, no records of operating results were obtainable. But it is only fair to say that the manufacturer was willing to substantiate his claim with the requested tangible operating guarantees. The results obtained at this writing are not absolutely conclusive, but it appears that the work of both types of machines will be well within their respective expectations.

Continuous countercurrent decantation is the cyanide process used, in which the pulp continuously flows toward the lower end while the clear solution continuously flows toward the upper end. The cyanide solution is entered at the Marcy mills and most of the values will be dissolved before reaching the first cyanide tank. The cyanide plant has five Dorr thickener tanks 40 by 12 ft. and four Dorr agitators 24 by 14 ft., arranged in the following order: thickener, three agitators, thickener, agitator, three thickeners. Each thickener has a Campbell and Kelly diaphragm pump located above the tank to pump the pulp into the following tank. The first thickener is taking the overflow from the Callow sloughing-off tank, the pulp discharged is pumped into the first agitator, and the clear solution overflow goes by gravity through a solution meter and thence into a 20 by 10-ft. press-solution tank. The pulp passes through the first three agitators and into the second thickener by gravity, thence by pump to the fourth agitator, thence by gravity to the third thickener, and thence by pump to the fourth and fifth thickeners and tailings launder respectively. The second thickener overflow is returned to the mill-solution supply tank at the head of the mill via a priming tank and centrifugal pump. The third thickener overflow is returned to the first agitator by similar means. The fourth thickener overflow may go by gravity to the third thickener or at option may be pumped to the fourth agitator. The fifth thickener overflow goes by gravity to the fourth thickener. Barren solution is added to the launder from No. 4 thickener to No. 3 thickener and fresh water to the launder from No. 5 thickener to No. 4 thickener. The three centrifugal pumps handling the clear solution are each connected to a fourth pump acting as standby. Each pump is direct-connected, motor-driven, and equipped with automatic float switch at the priming tank to shut off the motor should the priming tank be drained. A small compressor is installed to supply air to the agitators at 20 lb. pressure.

The solution from the first thickener after entering the press-solution tank is pumped by a centrifugal

TABLE 8—ASSAY OFFICE

	Labor	Material	Total
Excavation	$23.25	.....	$23.25
Concrete	13.14	$8.52	21.66
Machinery, f.o.b. Catman	.....	152.97	152.97
Machinery, erection	31.89	1.37	33.26
Building lumber	.....	296.06	296.06
Lumber framing and erection	107.90	4.86	112.76
Building covering in place	.....	89.70	89.70
Doors and windows in place	33.00	38.27	71.27
Wood tanks, f.o.b. Catman	.....	53.35	53.35
Wood tanks, erection	0.75	.....	0.75
Piping, f.o.b. Catman	.....	7.65	7.65
Electric wiring, f.o.b. Catman	.....	27.72	27.72
Electric wiring, erection	27.56	.....	27.56
Belting in place	.....	2.25	2.25
Engineering, field	6.65	.....	6.65
Furniture and fixtures	68.13	623.32	691.45
Painting	18.13	10.41	28.54
Small tools and equipment	127.50	395.32	522.82
Total assay office	$457.90	$1,711.77	$2,169.67

TABLE 10—WATER SYSTEM

	Labor	Material	Miscellaneous	Total
Bergman ranch:				
Well and pit	$1,425.07	$680.57	$49.41	$2,155.05
Plant and building	.....	272.87	.....	272.87
Pumping machinery, f.o.b. site	.....	1,480.04	.....	1,480.04
Pumping machinery, installing	21.62	10.92	1.00	33.54
Electrical equipment, installed	35.62	1,439.98	5.90	1,481.50
Pipe and fittings, f.o.b. Kingman	.....	8,727.80	.....	8,727.80
Pipe and fittings, hauling and distribution	.....	1,406.85	.....	1,406.85
Two storage tanks, installed, 75,000 gal	32.25	1,546.87	.....	1,579.12
One small tank	.....	71.10	.....	71.10
Pumpman's residence	91.27	886.47	.....	977.74
G. A. Heckler, contract	15.00	56.00	3,179.00	3,250.00
Engineering, field	71.45	.....	86.00	157.45
Total Bergman ranch	$1,692.28	$16,579.47	$3,321.31	$21,593.06
Well test	$126.75	$30.96	.....	$157.71
Big Jim to mill, system:				
Engineering, superintendence, maintenance	$6.00	.....	.....	$6.00
Pipe and fittings, f.o.b. Catman	.....	$2,169.34	.....	2,169.34
Pipe and fittings, distribution	43.11	.....	.....	43.11
Installing line	238.70	0.46	.....	239.16
Storage tank, installed complete	90.50	.....	.....	90.50
Total Big Jim to mill, system	$378.31	$2,169.80	.....	$2,548.11
Total water system	$2,197.34	$18,780.23	$3,321.31	$24,298.88

pump through a 3½ by 3½-ft., 28-frame Merrill clarifying press, the clarified solution going by gravity to a 20 by 10-ft. gold tank. From here a 7 by 8-in. Platt Iron Works pump sends the pregnant solution through two Merrill 36-in., 32-frame precipitation presses, zinc dust having been added my means of a feeder and emulsifier to the pipe from the gold tank to the triplex pump. Duplicate triplex and centrifugal standby pumps are installed.

Barren solution from the precipitation presses goes to a sump from whence it is pumped to the mill-solution supply tank. Refining of the precipitate is accomplished with a two-muffle Case roasting furnace and a Case tilting-crucible furnace.

The tank-settling area for the thickeners and the capacity of the agitators is calculated for treating 240 tons per 24 hours, but the height of the thickeners has purposely been increased by 2 ft., which will allow for the insertion of a false floor or deck in each tank, which with an additional set of rabble arms on the shafts, will bring the capacity of the thickeners up to 400 tons. Thus if the anticipated increase in production from 200 to 400 tons should have to be met, it will simply require the installation of the necessary agitators, a comparatively small item.

In addition, auxiliaries such as machine shop, blacksmith shop, warehouse and transformer house are built. An incline tramway is installed to haul supplies and construction material for the mine and mill, from the wagon road below.

The buildings are all timber framed and covered with corrugated iron, except the refinery, which is constructed of hollow concrete block walls, steel roof trusses and corrugated iron roof covering. The grinding and cyanide departments have concrete floors sloping ¼ in. per foot where possible and all draining into a sump on the lowest floor.

A comprehensive idea of the total cost of the installation as well as of the individual departments can be had from the attached cost distribution. Taking, for the purpose of comparison with the cost of other cyanide plants, what is generally understood to be part of a milling plant, such as crushing plant, mill proper, and refinery, shops, offices, store houses, assay office, and inclined railroad for distributing purposes, and allowing liberally for extending the cyanide plant to 400 tons capacity, the cost of the plant per ton of ore treated amounts to $520. This, in view of the fact that the mine is located 28 miles from the nearest railroad station and all the material had to be transported by motor truck or wagon, and that the purchasing orders were placed at a time when the various machines and materials were averaging at least 15 per cent above normal, is a very low figure.

The compactness of the plant, including the principal departments, such as crushing, milling and refining, is shown by comparison with two other cyanide plants recently designed by the writer; one 500-ton plant occupies 112 sq. ft. and one 350-ton plant 110 sq. ft. per ton of ore treated, while the United Eastern installation on a basis of 400 tons covers an area of only 70 sq. ft. per ton of ore capacity. The cost per ton treated of the 500-ton mill, with the main mill building being constructed of steel, was $930, while the 350-ton plant of identical construction as the United Eastern cost $681 per ton of ore treated. Both of these mills are situated on branch line railroads and were built at a time when prices of material were normal.

The Spectroscopic Determination of Small Amounts of Lead in Copper*

By C. W. Hill and G. P. Luckey†

The following experiments are the result of the need for a rapid method for the determination of small amounts of lead in copper for use in the factory control of copper refining. On account of delay in securing apparatus and the pressure of other work, the authors have not been able to conduct all of the desirable experiments incident to the problem, but are moved to publish the results of the work accomplished in the hope that others may find use for the method and so improve or modify it that it may be capable of broader application.

APPARATUS

The apparatus used consisted of a vertical arc and a small grating spectroscope, together with suitable resistances and condensing lens, shown diagrammatically in Fig. 1. The arc was formed between an upper negative electrode of half-inch (13 mm.) carbon rod and a small sphere of copper resting in a slight cavity in the lower positive graphite electrode. The spectrum was formed by a 2-in. (5 cm.) concave grating of 3 ft. (90 cm.) focal length ruled 15,000 lines to the inch (6000 per cm.). Lines of the first order spectrum were observed with an eyepiece magnifying ten times. For the determination of lead in copper, the brightest visible line in the lead arc spectrum (405.8 μμ) was observed. This line lies in the violet between the two bright copper lines, 405.29 μμ and 402.29 μμ. Fig. 2 shows the photograph of the spectrum as observed, with the lead and copper lines in prominence and the many fainter lines resulting from the carbon arc.

In later experiments, a rotating upper electrode was used. This steadied the arc materially and held the focus of the arc on the slit, so that the arc required no attention after starting.

PROCEDURE

Weighed samples of copper shot of known lead content were subjected to an arc of constant length and current. By means of a stop-watch the time was measured from the melting of the sample until the disappearance of the lead line in the spectrum. The end-point was easily determined, since the lead line lies almost above the first line of a carbon band. At first the line appears very bright, but as the lead disappears the line assumes the same brightness as the remainder of the carbon band of lines. It is much easier to match the line in brightness than to observe the final disappearance of a line.

OBSERVATIONS

Using the apparatus and method described, experiments were made using varying weights of copper samples (0.1 g. to 1.0 g.) containing different percentages of lead (0.004 to 0.216 per cent). The arc was main-

*A paper presented at the Thirty-second General Meeting of the American Electrochemical Society, in Pittsburgh, Oct. 3-6, 1917.

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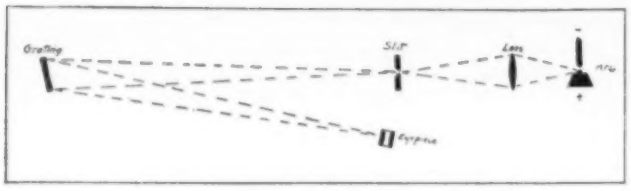

FIG. 1

tained at a length of 0.5 cm. and consumed 10 amp. on a 220 V. circuit. The results are tabulated in Table I.

TABLE I.
Time for Different Weights of Samples.

Per Cent of Lead in Sample	Time in Seconds for Weights of Samples Given					
	0.1 g.	0.2 g.	0.4 g.	0.6 g.	0.8 g.	1.0 g.
0.004	...	14	20	...	...	...
0.005	...	...	...	67	98	150
0.006	...	34	40	...	...	...
0.008	...	50	67	...	...	...
0.059	...	94	...	...	...	...
0.011	22	65	87	135	173	210
0.014	...	67	95	...	...	...
0.016	...	...	120	...	...	...
0.028	...	92	...	215	240	277
0.031	...	...	155	...	...	...
0.045	35	...	180	...	...	...
0.062	50	140	227	...	...	...
0.097	...	203	...	...	...	...

The size of sample which will give the best results is dependent upon the range of lead content to be determined and upon the size of electrodes and current conditions. With a given arc, larger samples increase the accuracy at low percentages of lead, but lengthen the time of measurement for samples of high lead content. For our specific problem and arc arrangement, samples of 0.4 g. are the best.

Table II shows the results of two runs made several months apart, one determination being made with a stationary upper electrode and the other with a rotating electrode. Individual readings are given to show the deviation from the average.

TABLE II.
Check Runs With 0.4 g. Samples.
(Time in Seconds)

Per Cent Lead by Analysis	Stationary Cathode	Rotating Cathode			
		Averages	Individual Readings		
0.004	20	26	25	23	29
0.006	40	...	...	...	...
0.008	67	62	65	60	60
0.011	87	96	100	95	98
0.014	95	110	(From curve)		
0.016	120	120	120	120	120
0.028	146	151	146	155	154
0.031	155	160	(From curve)		
0.045	180	194	(From curve)		
0.062	227	240	235	240	245
0.097	...	313	290	315	334
0.119	...	331	325	329	338
0.156	...	387	375	400	...
0.216	...	474	485	463	...

It is to be noted that the standardization of the method was made by use of factory samples the chemical analysis of which had been made with great rapidity and with the usual errors incident to the method. The readings were taken as a rule at random, with lead content unknown to the person observing the spectrum. Repeated runs by different observers showed variations of the same magnitude as those in Table II.

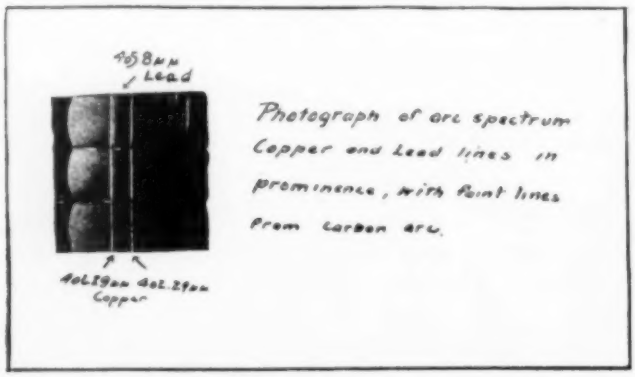

FIG. 2

In using the method as a check on the refining process, it is not necessary to have a complete standardization curve. Samples of satisfactory material may be run from time to time, and the refining process continued until furnace samples show a disappearance time equal to or less than that of the standard sample. If desirable, the disappearance time could be plotted against furnace operating time.

For factory use it is proposed to use a suitable spectroscope, if one can be obtained which has sufficient diffraction to show the lines distinctly. A Joly balance will be substituted for the usual analytical balance, since it is sufficiently accurate and is better adapted to factory usage.

CONCLUSIONS

From the above experiments it is concluded that the empirical method outlined permits the rapid determination of small amounts of lead in copper. It is necessary to maintain constant conditions of arc and to standardize the apparatus against known samples. Several check readings should be taken when considerable accuracy is desired.

For control work the time of disappearance of the lead for a satisfactory sample of copper may be used as a standard, and the refining process carried on until the furnace sample shows an equal time of disappearance.

OTHER APPLICATIONS

The use of the arc is limited to the determination of small amounts of impurities which are volatilized at a comparatively low temperature in the presence of a metal which is not rapidly volatilized at a comparatively high temperature and which gives a steady arc, the existence of strong characteristic spectrum lines being assumed. (In the present case the above statement should probably be modified so as to apply to the oxides of the metals rather than the metals alone.) Some metals would give better results in an inert atmosphere.

The method might be applied to metals of low boiling point or even to salts, by substituting a heating strip in place of the arc and securing the arc or spark spectrum from the vapors arising from the heating strip.

Illinois Station of the Bureau of Mines

The United States Bureau of Mines has broadened the scope of its station at Urbana, Ill., to include work in coal and metal mining and the metallurgical industries of the Middle West. The present safety work will be continued and all work will be conducted under a cooperative agreement with the mining department of the University of Illinois. The bureau staff is under the superintendence of E. A. Holbrook, supervising mining engineer and metallurgist. Other members are W. B. Plank, in charge of mine safety, and F. K. Ovitz, chemist.

Recent Metallurgical and Chemical Patents

Aniline Oil and Aromatic Amins.—OTTO SCHMIDT and HUGO BLANKENHORN, Germany: Process of producing aromatic amins such as aniline by catalytically hydrogenating aromatic nitro compounds such as nitrobenzene consisting in treating an aromatic nitro compound in the presence of a contact mass, with a gas mixture containing carbon monoxid and at least one volume of water vapor for each three volumes of the carbon monoxid. (1,237,828. Aug. 21, 1917.)

Sulphonic-Acid Salts from Waste Liquors.—A method of treating alcoholic alkaline waste liquors obtained in refining mineral oil is patented by ALBERT WOLFF, of Hamburg, Germany. The waste liquor is treated with dilute sulphuric acid, repeatedly washing the sulphonic acid obtained with dilute sulphuric acid, adding the quantity of alcohol required for dissolving the oil still present, separating the layers thus formed, neutralizing the sulphonic acid solution with sodium carbonate free of water, removing the deposit and evaporating the liquid. (1,240,523, Sept. 18, 1917.)

Lactic Acid.—A process for producing U. S. P. lactic acid from the commercial grade is patented by EDGAR T. OLSON, of Ann Arbor, Mich., and assigned to the Detroit Organic Chemical Co., of Detroit, Mich. The principal claims follow:

"In the process for the production of lactic acid from crude materials, preparing a partially purified calcium lactate, treating the calcium lactate with an aqueous solution of sulfuric acid, thereby producing a mixture containing calcium sulfate and lactic acid, drying said mixture, heating the dried mixture to approximately 130 deg. C., thereby converting the lactic acid into lactid and anhydrid, removing soluble impurities from the resulting mixture, and subjecting the purified mixture to the action of steam, thereby hydrolyzing the lactid and anhydrid to lactic acid and removing the latter in the pure state." (1,240,766, Sept. 18, 1917.)

Urea.—A process of making urea is the subject of two patents of JOHN E. BUCHER, of Coventry, R. I., assigned to the Nitrogen Products Co., of Providence, R. I. An alkali cyanate such as potassium is treated with ammonia, and carbondioxide is passed into the solution. The potassium precipitates out as potassium bicarbonate with the formation of ammonium cyanate, which on heating changes to urea. (1,241,919-20, Oct. 2, 1917.)

Modifying Acetyl-Celluloses.—A process for converting acetyl-celluloses into products easily and viscidly soluble in acetone is patented by E. KNOEVENAGEL, of Heidelberg, Germany, and assigned to Knoll & Co., of Germany.

The process consists in rearranging by heating and in a dissolved or at least strongly swelled state, acetyl celluloses which are insoluble in acetone. This conversion may be carried out in the presence of disintegrating catalysts possessing a weak hydrolyzing action, such as sulphites, bisulphites, chlorides or nitrates with on (in the absence of acid anhydrids) without the presence of water or even by water alone without a catalyst. In the presence of acid anhydrids the water may be replaced by other substances which decompose acid anhydrids, such as alcohol, glycerin, etc. The process is based upon the new knowledge that the saponification and still more the hydrolytic decomposition of acetyl cellulose must take place at the very most to a slight degree only in the transformation of acetyl celluloses insoluble in acetone into products soluble in acetone, if valuable acetyl-celluloses viscidly soluble in acetone are to be obtained. (1,241,995, Oct. 2, 1917.)

Ethyl Chloride.—B. S. LACY, of Sewaren, N. J., patents a process for making ethyl chloride. The patent is assigned to the Roessler & Hasslacher Chemical Co., of New York.

The process consists in mixing chlorine gas with not less than about three times its volume of ethane, exposing said gas mixture to a temperature of approximately 300-550 deg. C., washing the obtained reaction gases with water to remove the hydrochloric acid gas, separating the ethyl-chloride from the unusual ethane by compressing the mixture to a pressure not exceeding about fourteen atmospheres, drying the gas mixture while in the compressed state and cooling the mixture in the compressed state to about —20 deg. C. (1,242,208, Oct. 9, 1917.)

Celluloid Substitute.—HENRY DREYFUS, Basel, Switzerland. Production of celluloid substitutes by the employment of a mixture of trichlorethylene and alcohol, as a solvent for certain particular cellulose acetates soluble therein, to which camphor substitutes may be added. The new celluloid substitutes are claimed to be free from certain so-called objectionable features possessed by celluloid and by many of the celluloid substitutes heretofore employed, in particular, the objections of being brittle, non-transparent and unstable. The solution of the cellulose acetates, with or without camphor substitutes, in the mixture of trichlorethylene and alcohol, can also be employed for varnishes, coatings and the like, and for the manufacture of films. (1,242,783, Oct. 9, 1917.)

Various Chemical Processes

Thickening Solutions and Emulsions.—PAUL ASKENASY, Karlsruhe, Germany. When cakes of pulverized gelatin are placed in a liquid, such as milk, for example, a thickened deposit of the liquid is obtained, as the water contained therein will be absorbed by the gelatin. The swollen gelatin, which heretofore was only used in form of cakes, leaves or powder, however, had the disadvantage that its several particles would stick together, whereby the separation of the liquid, and in particular the drying and renewed employment of the gelatin matter was rendered difficult. According to the present invention the gelatin is employed in form of balls, globules, beads, polyhedrons and in general of a form which is between a ball and a cube. It has been found that when gelatin of such form is used the gelatin particles, even during the drying process, will not stick very much together. (1,234,714, July 31, 1917.)

Dry Distillation of Cellulose Materials.—H. VON HOCHSTETTER, Constance, Germany. Observation has been made that the yield of acetate of lime in wood distillation undergoes a considerable increase if the charring period proper (the period of self-charring) be made as short as possible; *i.e.*, that as soon as one notices any sign of an exothermic reaction taking place within the retort the supply of heat is so considerably and forcefully increased that from this time on the temperature prevailing in the retort for the further run of the distillation is about 400 deg. centigrade or higher. (1,241,789, Oct. 2, 1917.)

Removing Combined Sulphur from Rubber.—DAVID SPENCE, Norwalk, Conn. The process consists in subjecting the vulcanized rubber in solution to the action of anhydrous caustic alkali in a finely divided state at a suitable temperature and under conditions of agitation adding a suitable quantity of an acid to neutralize the alkaline ingredients remaining in the solution, and precipitating the rubber from the solution. (1,235,852, Aug. 7, 1917.)

Pyroxylin Composition.—WALTER E. MASLAND of Philadelphia, Pa., has patented a pyroxylin composition containing aldol and especially applicable to the production of compositions for making coated fabrics. The patent is assigned to the du Pont Powder Company. One example of the composition contains twenty parts pyroxylin, eighteen parts aldol, fifty-two parts castor oil, a pigment and a volatile solvent, the volatile solvent being from two to four times the weight of the remainder of the whole composition, and the solvent being comprised of about sixty parts benzol, thirty parts alcohol and ten parts commercial ethyl acetate. (1,234,921, July 31, 1917.)

Phenol Condensation Products.—KONSTANTIN TARASSOF of Dobroslobodsky, Russia, has patented a process for making phenol condensation products by causing phenol, formaldehyde, sulfonated resin oil and sulfo-acids obtained by treating crude petroleum with sulphuric acid, to react together. (1,235,507, July 31, 1917.)

Cellulose.—A new cellulose compound is patented by EMILE LÉON BLOCH-PIMENTHEL of Paris, France. The process comprises treating cellulose with formic aldehyde and ferric chloride, drying in vacuum and heated in an oven sufficiently to form trioxymethylene, and cause same to react with the cellulose and ferric chloride. (1,234,720, July 31, 1917.)

Acetyl-Cellulose.—Acetyl-cellulose and the process of making same is the subject of two patents of WILLIAM G. LINDSAY of Newark, N. J., assigned to the Celluloid Company. The object is to accomplish acetylation of the cellulose in fibrous form without solution of the cellulose and without the use of sulphuric acid, sulfo-acids, or other constituents tending to induce decomposition. The cellulose is given a preliminary treatment with acetic acid and zinc chloride, and then subjected to the acetylating bath, which consists of acetic anhydride and benzene. (1,236,578-9, Aug. 14, 1917.)

Treatment of Sulfite Liquor.—A process of precipitating organic substances in sulfite liquors is patented by HANS BRUN LANDMARK of Drammen, Norway. It is accomplished with sulfuric acid produced by oxidation of SO_2 in solution with an electric discharge. (1,236,948, Aug. 14, 1917.)

Alcohols.—OSKAR MATTER of Cologne, Germany, has patented a method of manufacturing polyvalent alcohols. The method consists of heating a chlorinated hydrocarbon in a closed vessel in the presence of alkali bicarbonate and copper, the amount of water highly exceeding that of unaltered chlorinated hydrocarbon present. (1,237,076, Aug. 14, 1917.)

Increasing Catalytic Action.—The use of atinic rays for increasing catalytic action is the subject of a patent of FREDERICK G. KEYES, assigned to Cooper-Hewitt Electric Company of Hoboken, N. J. The method consists in subjecting a reaction mixture to atinic rays from a source which generates more heat than desired for the reaction, and protects the reaction mixtures by a vacuum chamber interposed between the source and the mixture. (1,237,652, Aug. 21, 1917.)

Synopsis of Recent Metallurgical and Chemical Literature

Gold and Silver

Precipitation and Smelting at the Great Fingall Mine, Western Australia.—In the monthly *Journal* of the Chamber of Mines of Western Australia for July, 1917, Mr. W. B. CHOMLEY describes the methods used at the above property. For an average month when the tonnage treated was 4220, the cost was 14.44 cents per ton of ore treated.

Of the tonnage milled some 66 per cent is treated as sand by leaching, and the remainder as slime by decantation. The solutions are precipitated together. Approximately 300 tons of solution is passed through the boxes every 24 hours having a cyanide strength of 0.04 per cent KCN and an alkalinity of 0.015 CaO. The head value of the solution entering the boxes has an average value of 5s. to 7s. ($1.20 to $1.70), and the tails vary from 0.2s. to 0.5s. (5 cents to 12 cents). The former (0.2) appears to be the limit to which the gold in the solution can be reduced, and it is admitted that this figure might be improved upon by some more active precipitant than zinc, or some other form than shavings.

The precipitation boxes—of which four are kept in use—are built of wood, and are considerably larger than those installed on most mines in this state. Each has seven compartments with a capacity of 16 cu. ft., but only five compartments are in use. This makes a total of 320 cu. ft., or 1 cu. ft. (approximately) per ton of solution per 24 hours. Each compartment holds about 120 lb. of new teased zinc shavings, or slightly more of old zinc than has been in use some days. An even and equal flow of solution is maintained through the boxes by having a suitable reducer on the end of each delivery pipe. All the feed pipes draw from one trough, which has an overflow leading back to the mill circuit.

The boxes are cleaned up twice a month, and the zinc is moved up once between clean-ups. At the mid-monthly clean-up the zinc is only washed and returned to the boxes after the sludge is removed. Frequent tests have demonstrated this intermediate clean-up to be necessary to maintain good precipitation.

The addition of lead acetate has been tried at various times and in various ways, but results have failed to show that it exerted any beneficial effect. Experience has proved that, so long as the cyanide strength is maintained above 0.03 KCN and no sudden drop in the alkalinity takes place, the box tail values entirely depend upon the ratio of solution flow to zinc area. When overloading takes place, the falling off in precipitation is not simply in proportion to the increased flow, but is very much greater. Cases have been observed where the tails of one box have risen to ten times the value of its neighbors, and the cause has been traced to an accident which increased its flow apparently not more than 50 per cent, and on this being rectified they fell to normal without any addition or moving of the zinc.

At the month-end clean-up only the very short zinc

is dissolved, but all the rich zinc which is strong enough to be of further use is soaked in dilute sulphuric acid, and is subsequently scrubbed and returned to the boxes. For this purpose a spare precipitation box is used. The compartments of this are partly filled with a solution of about 5 per cent H_2SO_4. The zinc after having been roughly washed in its own solution is placed in the acid and left to soak for several hours. When the adhering gold slime has been loosened sufficiently to permit of its being easily rubbed off, the acid is washed away by running a stream of water through the box, and the zinc can then be handled without inconvenience. Some gold always remains on the zinc, which usually assays about 0.04 per cent or 5s. ($1.20) per pound after being washed, while the gold removed by this process amounts to from five to ten times that value.

The slime consists of a 20-in. ten-frame press. Formerly this was filled by air pressure from a monteju, but this has been discarded in favor of a vacuum pump. The delivery ports of the press have been altered to connect with the suction of the pump, while the intake of the press connects with a pipe line having suitable connections opposite each acid tub and precipitation box. To these connections can be attached a length of hose fitted with a scrim-covered funnel, which can be dropped into one compartment to remove the sludge while washing is proceeding in another compartment. After the press has been used on "cyanide" slime, and before it is used for "acid" slime, it is an invariable rule to give it a water wash to remove traces of cyanide from the cloths. If this is not done the acid, in coming in contact with the cyanide, will form various gelatinous compounds which retard filtration. This method of using a closed filter in conjunction with a vacuum pump has several advantages over both the ordinary pressure filter and the open-leaf vacuum filter. Unlike the former, it does not blow out when a leak occurs, and at the end of the clean-up there is no slime left behind in the monteju, which usually can only be recovered at the cost of some time and labor. The low pressure obtained by a vacuum is compensated by the saving in time through being able to operate the filter continuously until full, instead of intermittently, as is the case when using air pressure. It has an advantage over the open vacuum filter inasmuch as the cakes can be dried by air pressure and delivered in a convenient form. Over both it has the advantage of being able to collect the sludge and cloudy solution from the boxes and deliver the slime ready for roasting without intermediate handling.

The slime is roasted on trays in a reverberatory furnace, fluxed with 40 per cent of borax and 15 per cent of sand and smelted in crucibles in well furnaces. Formerly a tilting furnace was used, but abandoned owing to the small amount of slime to be smelted. The smelted bullion has an average fineness of 760.

Flotation

Mt. Lyell Company's Flotation Plant.—One of the most recent installations of the flotation process is that of the Mt. Lyell M. & R. Co., Queenstown, Tasmania. As described in the *Mining and Engineering Review*, September, 1917, the treatment plant is one of the most up-to-date and compact of its size in the commonwealth. The ore contains chalcopyrite and pyrites finely disseminated in a schisty gangue. The average mineral content is about 3 per cent copper, 0.2 oz. silver and about 0.5 dwt. gold.

The flotation plant was started on Feb. 17, 1916, and the tonnage treated up to Mar. 31, 1917, was 17,027 tons, of which 3530 tons was low-grade ore. The crude ore is tipped in a bin of 150 tons capacity, fed over a grizzly into a jaw crusher and reduced to 2 in. The crushed material is then elevated to a rubber belt conveyor which delivers into two fine-ore bins. From here it is fed by means of roller feeders on to submerged shaking screens of ⅛-in. diameter; the oversize from the screens passes through two sets of crushing rolls, thence on to an elevator and back on to the shaking screens. Finally the whole of the material passes through the screens, is elevated, passes an automatic sampler from which the daily crude ore sample is obtained, and is delivered into a diaphragm cone classifier, 5 ft. in diameter by 6 ft. 6 in. deep, with a diaphragm 6½ in. in diameter, near the bottom, leaving an inch and a half annular opening. This classifier separates the sands from the slime.

The slime overflows to two Dorr thickeners, 20 ft. in diameter and 10 ft. deep. The discharge from the classifier is divided between two tube mills 16 ft. 5 in. long and 5 ft. diameter, revolving at the rate of 29 r.p.m. The mills are equipped with scoop feeders and are motor driven through gears. The discharge from the tube mill joins the Dorr thickener discharge and is elevated into the minerals separation flotation boxes of standard size having 18-in. impellers revolving at the rate of 320 r.p.m. There is a series of twelve mixing boxes with corresponding spitz or flotation boxes. Eucalyptus oil is sometimes added to the mixing boxes, but usually to the tube mills. The consumption of oil is slightly less than ¾ lb. to the ton of ore treated. Oil costs about 8d. (16 cents) per pound. The tailings from the minerals separation boxes flow direct to the dam.

A feature of the process is that no return water could be used on account of the excessive sliming of the gangue in the ore. The fine concentrates are at present being re-treated in a simple apparatus designed by the local staff, with considerable improvement in grade.

The final concentrate is elevated into steel settling tanks 20 ft. diameter and 8 ft. deep, provided with filter bottoms and with vacuum pumps attached. The concentrates are shipped from these tanks in trucks to the sintering plant. An Oliver continuous filter is being erected for the continuous filtering of the concentrates.

The whole plant is driven by independent motors, is extremely flexible, and has a capacity of 250 tons a day when running three shifts. At present only one shift is being run, and that intermittently on account of the irregular ore supply.

Canadian Wood Oils for Flotation.—A series of tests on Canadian wood oils and their use in flotation on cobalt ores is described in the *Canadian Chemical Journal* for November, 1917. The authors are R. E. GILMORE and C. S. PARSONS, the former in the Forest Products Laboratories of Canada and the latter in the Ore Dressing Division of the Mines Branch. The collecting of the wood oils was planned and carried out by the Forest Products Laboratories and the flotation tests were made by the Mines Branch. On account of the diffi-

culty which the flotation plants, the number of which was rapidly growing, reported in obtaining an adequate supply of imported pine oil, it was decided to investigate the possibilities of either finding a substitute for pine oil which was found necessary as a selective frothing oil, or of producing a satisfactory grade of pine oil in sufficient quantities from Canadian resinous wood waste. A large number of oils was collected and tested, including pine oils and creosote oils from the United States.

Among the first series of oils tried out were the original crude oils as collected. A sample of the total distillate, being the combined fractions from a distillation run, was in each case saved and tried out to see if the removal of free carbon and heavy pitch or coke residue from the oil improved its flotation value.

Individual fractions and groups of fractions were saved for the purpose of finding out just what part of a crude oil was of most flotation value.

Preliminary chemical separations of the hardwood creosote oils into neutral and acidic (phenolic and creosotic) constituents were carried out and the respective flotation values of these two group separates tried out.

A description of all the oils submitted for flotation tests is given in a table. Judging from actual flotation results for cobalt ore the use of steam distilled pine oil is to be recommended by the authors in preference to the destructive distillation grades, and graded specifications approaching 95 per cent distilling between 190 deg. C. and 220 deg. C. with the proper specific gravity range seem worthy of consideration in buying pine oil for flotation purposes. A pure pine oil is not always necessary for flotation purposes, but in using destructive distillation grades their value appears to be in direct proportion to the pine oil content as defined above.

In Canada the most promising resinous wood materials are the red (Norway) pine stumps of Northern Ontario and the western yellow pine stumps of British Columbia. The old stumps from ten to twenty years after felling the tree in many cases have sound hearts rich in oleoresin. Although the rosin content is high, the yield of wood turpentine is only fair and the proportion of true pine oil is small compared with the standard species, longleaf southern pine. In the Southern States the yield of pure pine oil is 2 3-5 United States gallons per cord of about 4000 pounds from the best grades of resinous wood waste. From the above Canadian woods the crude pine oil fraction, containing more or less "light oil" distilling between turpentine and pine oil proper, amounts to about 4 Imperial gallons per 2600 pounds cord and only a small proportion of this can be considered as true pine oil. By using two or three times the usual quantity of the sample, fairly satisfactory flotation results were obtained. All attempts to utilize the whole crude oil distillate or its turpentine or rosin oil content met with failure in this investigation. As pine oil is essentially a by-product of turpentine and rosin recovery from resinous wood waste and as this recovery industry has not yet shown prospect of profitable establishment in Canada, there is little promise of obtaining a commercial supply of frothing oil suitable for cobalt ores from Canadian resinous wood waste. In this connection the recent statement of Professor H. K. Benson of the University of Washington, who has investigated wood waste industries for the United States Government, is significant, viz.: "The commercial status of the softwood distillation industry is unsatisfactory in the Pacific States, in the Michigan and in the Wisconsin districts." However, considerable commercial progress has recently been made in the Southern States on richer material after a series of failures, and it is to be hoped that technical investigation will in time place the whole resinous wood industry on a sound commercial basis.

In discussing hardwood oils as substitutes for pine oil the authors point out that hardwood creosote oils can be drawn off separately as crude oils in the process of refining the wood alcohol and acetic acid. The indications are that they can be used as frothing oils in place of pine oil. While the yield per cord is about the same as for pine oil from longleaf Southern pine, the supply is comparatively large, there being over 500 cords of hardwood distilled daily in Canada at present and over ten times this amount in the United States, mostly in the border states.

Other hardwood oils mentioned are heavy yellow ketone oil and ketone residue, by-products of the manufacture of acetone from gray acetate of lime. While the yellow ketone oil is already of considerable value in the industries, its value as a flotation frothing oil is important especially in an alkaline pulp where it gives a high grade concentrate. Ketone residue, which is black and syrupy in nature, is produced in fairly large quantities and has noticeable collector values, as well as being a good frothing agent. This oil deserves more attention, the authors say, not only for cobalt ores, but for use alone with other ores, where it has very promising qualities.

Miscellaneous

Calcium Silicates as Fertilizers.—At the meeting of the American Chemical Society in Boston, in September, ALFRED H. COWLES presented some interesting data on calcium silicates and their use in supplying lime and soluble silica for plant growth. The author presented a paper at the Eighth International Congress of Applied Chemistry describing a method of manufacturing alumina, hydrochloric acid, caustic alkalies and a white hydraulic cement from salt, clay and lime. (See this journal Oct., 1912, for a complete description.) In that paper was explained how an artificial alkali-alumina-silicate could be produced and how, by grinding it with the proper amount of lime and passing the mixture through a rotary furnace, a sinter could be formed that would have the following composition, provided the temperature of the furnace was not so high as to volatilize the alkali constituent:

Dicalcium silicate Dialkali aluminate

$$x[(CaO)_2SiO_2] + 1[(Na_2O)_2Al_2O_3]$$

Here we have the disodium aluminate, a very soluble compound in water, and the x molecules of dicalcium silicate, an insoluble compound in *pure* water. Therefore, it was explained, that by leaching, the dialkali aluminate could be almost completely separated leaving dicalcium silicate as a residual product. From this, it was proposed to produce a cement. This treatment of a proper mixture of silicates with lime and soda carbonate to produce the above product is covered by a patent issued to Adolf Kayser which patent is owned by The Electric Smelting & Aluminum Company of which the author is president. He did not, therefore, feel jus-

tified in mentioning an unpatented improvement (patents are now pending), namely, that the product could be so made and still the leaching be effectively performed with the alkali metal oxide ratio to alumina as low as one and twenty-five hundredths (1.25) molecules of alkali to one of alumina in the sinter. Under these conditions he had discovered that he could leach as high as eighty-five and three-tenths (85.3) per cent of all the alumina away from such a sinter, leaving the dicalcium silicate with some alumina and a little soda in the residue. This proved that fusion or sintering could be effected at a low enough temperature to prevent loss of potash, and that such minerals as potash feldspar and potash mica schists could be treated with the right amount of lime to form dicalcium silicate, and a calcium aluminate with liberation of potash which would be available as a fertilizer. Very encouraging experiments with impure potash feldspar had been made.

The following remark occurred in the paper:

> This process also furnishes a key to unlock the stores of potash from the world's mountainous masses of feldspar.

At the time of that paper, lime was known to be of value as a fertilizer, silica was known to be present in large amounts in the skeletons of all plants, but he did not know that soluble silica had been discarded as an essential fertilizer by plant physiologists.

The author had made experiments which showed that limes made a great improvement in the growth of plants over the native soil and that the dicalcium silicate or calcium hydrate plus hydrated silica showed a very marked gain in luxuriance of growth over the lime treated soils. The author then gives a long discussion and cites experiments showing that soluble silica such as furnished by this silicate is an essential fertilizer and it renders available tremendous resources of native raw materials from which to produce fertilizers. In an addenda to the International Congress paper he also states that all obstacles to the eventual complete success of the manufacturing process have been surmounted at his plant in Sewaren, N. J.

Scientific Management in the French Chemical Industry.—A writer in a recent issue of *La Revue des produits chimiques*, according to the *Chemical Trade Journal* (London), observes that the Taylor system, as generally understood, can only be applied in industries the manual work of which admits of easy analysis into simple and continuous movements, or "rhythmic periodicity." That is to say, it is chiefly applicable in mechanical or engineering industries and to a much less extent, if at all, in the chemical industries. This, however, does not preclude the possibilities of applying to the chemical industries the principles of scientific organization in the best and widest sense of that term. Taylor's system is merely an application of the Cartesian analysis. The author of the system was a good analyst but a bad synthesist, and in building up his system he overlooked the unity of control and inter-relation and co-ordination of the different parts of a whole which are supremely essential. In the chemical industries it is the man more than the system which counts, and so far as France, at all events, is concerned, it is confidently hoped that, notwithstanding the ravages of the war, there will still be plenty of men able to lead and to organize.

The chief point of the article referred to is, however, the pressing need for educated and skilled workmen—not necessarily men trained according to the Taylor plan, which, as already noted, is hardly applicable, but men of trained intelligence, or, in other words, what the author calls "professional workmen." The great weakness of the French chemical industry, says the writer, is that the number of properly trained workmen is lamentably small. This is due to a variety of causes, of which the chief are the decline of the apprentice system, the absence of suitable means of instruction and training, and the "deplorable policy of the trade unions."

Motti and Fourmond, in a book recently published in Paris by La Société d'Etudes Economiques et Sociales, have determined by experiments that 100 average workmen are only able to do the work of 65 properly trained men, representing a loss by inefficiency of 35 per cent. The disastrous consequences of this to the employer, to the workmen, and to the community in general need no emphasis. According to French official statistics, the number of students passing through commercial and technical institutes in France per annum is about 35,000, as compared with 500,000 in Germany. The number of persons engaged in commerce and industry in France is estimated at 9,300,000, and the number of young persons under 18 years of age is about 850,000. It follows from this that the greater part of the persons employed in industry are very imperfectly trained. The position is still worse in regard to agriculture.

It is necessary to reform the whole educational system of the country and to aim at producing trained men of action rather than academicians.

A Portable Belt Conveyor

A portable belt conveyor which appears to have many uses has recently been developed by the Barber-Greene Company, Aurora, Ill. Two illustrations of different types of this conveyor are shown in Figs. 1 and 2.

The most extensive use of this conveyor is for handling coal, especially in unloading cars to bins or open piles. It is also being used, however, for handling other materials such as clay, brick, crushed stone, salt, etc. In the case of salt and chemicals injurious to steel, a wood frame is furnished with the conveyor.

All of the conveyors are self-contained with the electric motor mounted within the conveyor frame. In this way, the one machine can be applied to a variety of conditions with very little difficulty in moving from one

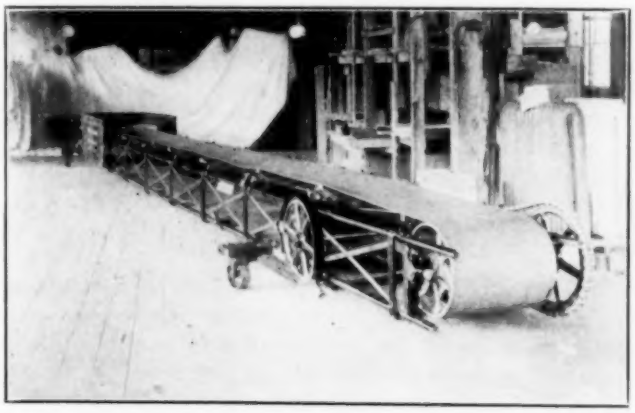

FIG. 1. PORTABLE BELT CONVEYOR FOR WAREHOUSE USE

FIG. 2. HANDLING LUMP COAL TO OUTSIDE PILES

operating position to another. A special type of frame construction is employed which has been found to be more than ample for all requirements to which it has been applied, and at the same time is sufficiently light to make the conveyor really portable.

In some cases, material is shoveled into the conveyor hopper and discharged over the other end onto the pile or into another conveyor. In other cases it is possible to let the material flow by gravity into the conveyor hopper and the material is thus transferred with little or no manual labor.

Fig. 1 shows a conveyor for warehouse use. The discharge end may be fixed to any desired height and frequently is arranged with height sufficient to discharge in a hopper of a similar conveyor. The hopper may be set at any point on the conveyor convenient for the workmen or the conveyor may be provided with a continuous hopper. Fig. 2 shows a conveyor handling lump coal to outside piles.

Some Substitutes for Platinum Ware

By Roy Franklin Heath*

The great increase of the value of platinum during the past few years has warranted the production of many substitutes. Many of these substitutes are successful, but their use is limited. By careful limitation of the work to be done by each of these substitutes, it is possible to do away entirely with platinum crucibles. At the present time it is not only right, but patriotic that there be a less demand of platinum ware from laboratories which can do away with the use of this substance without impairing results and at the same time at less expense.

The substitutes to be considered here are gold, silver, nickel, composition and fused quartz. Each of these have uses, some of which are very limited. The first four named will stand a harder usage than platinum crucibles of good quality, while fused quartz answers many purposes, but requires greater care in handling.

EFFECT OF HEAT ON THE CRUCIBLES

The effect of heat on these crucibles is interesting. This test was carried out by heating the weighed crucible in the direct Bunsen flame tip for a period of 32 hours. They were then cooled and weighed. The differences in weight were noted and were as follows:

Crucible	Original Weight	Weight After Heating	Loss or Gain
Platinum	26.100	26.138	.038
Gold, pure	19.261	19.263	.002
Silver, pure	24.536	24.540	.004
Nickel	32.560	32.559	.001
Composition	28.920	28.923	.003
Fused quartz	28.102	28.100	.002

SOLUBILITY IN ACIDS

The solubility of the various crucibles in concentrated acids were tested. In conducting these tests the crucibles were first cleaned with sand, washed, dried and weighed. They were then immersed for a period of thirty minutes in the acid, washed with water, dried, weighed and the difference in weight noted.

Crucible	Original Weight	Weight After Immersion	Loss
Platinum	30.02	30.019	.001
Gold, pure	25.061	25.051	.010
Silver, pure	32.503	32.495	.008
Nickel, wrought	34.265	34.141	.124
Composition	31.180	31.176	.004
Fused quartz	27.901	27.899	.002

Hydrochloric acid.
Specific gravity, 1.2.
Time, 30 minutes.
Temperature, 18.5 deg. C.

Crucible	Original Weight	Weight After Immersion	Loss
Platinum	31.680	31.680	.000
Gold, pure	26.753	26.751	.002
Silver, pure	33.568	33.462	.106
Nickel, spun	32.552	32.493	.059
Composition	31.002	31.000	.002
Fused quartz	29.690	29.687	.003

Sulphuric acid.
Specific gravity, 1.84.
Time, 30 minutes.
Temperature, 18.5 deg. C.

Crucible	Original Weight	Weight After Immersion	Loss
Platinum	30.065	30.064	.001
Gold, pure	26.890	26.886	.004
Composition	31.567	31.565	.006
Fused quartz	29.736	29.732	.004

Nitric acid.
Specific gravity, 1.42.
Time, 30 minutes.
Temperature, 18.5 deg. C.

As a substitute for solid platinum ware there is on the market a platinum clad wire and platinum plated ware. This substitute answers the purpose very well for the time being and at a cost of about one sixth the original cost of the solid goods. The lasting qualities of this platinum plated ware is well known. It is well to remember that nascent chlorine, iodine and bromine attack platinum. Fusions containing sodium, potassium, or barium hydroxides should not be effected in platinum or platinum clad ware.

Nickel ware or crucibles can take the place of platinum in electrolytic analyses and other operations where strong acids are absent. Nitric and sulphuric acids are its solvents and should not be present. It can be used in igniting and weighing operations, but it is not advisable to make alkaline fusions in nickel vessels.

Gold crucibles and ware make a good substitute where a high temperature is not needed. Being nearly insoluble in acids and forming no compounds with alkaline hydroxides they are useful in making fusions which cannot be made in platinum vessels. However, gold is attacked when free chlorine, bromine or iodine are liberated. It is more stable in the rough flame than platinum and does not combine with carbon. It can be used in making fusions (not alloy), as the anode and cathode in electrolysis, drying, igniting and weighing. As it melts around 1000 deg. C. care should be taken in heating.

Silver has more uses in the laboratory as a plating agent than in ware. Silver crucibles are attacked by

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nitric, hot sulphuric, the nascent halogens, sulphur fumes and sulphur. It is not attacked by the alkaline carbonates or hydroxides and is used for their fusions and solutions. It can also be used in weighing, ignition, etc.

Fused quartz can be used in making fusions where any of the halogens are liberated. It is not attacked by any acid except hydrofluoric. It has a high fusion point (around 1700 deg. C.) It can be used in general laboratory work, ignitions, fusions, weighing, etc., etc.

A composition ware composed of Canadium I part, palladium I part, platinum 2 parts, and nickel 6 parts, makes an excellent substitute for platinum. Ware and crucibles made from this alloy have been in use, in the writer's laboratory for a period of eight months, with satisfactory results. Its fusion point is around 1570 deg. C., it is not readily attacked by any single acid, but nitric acid attacks it most. It is attacked by the halogens, and the same care should be observed with this ware as if it were of platinum.

As a general laboratory ware, in crucibles, and as anode and cathodes in electrolyses this alloy can be used with success and seems to be a perfect substitute for platinum at about one-half the cost.

Protective Treatments for Cement Floors Subjected to Injurious Liquids

By W. P. Anderson

President, The Ferro Concrete Construction Co.

The Ferro Concrete Construction Company has been making a series of tests to determine the best treatments for concrete floors that are subject to harmful liquids.

Sixty concrete slabs were made, 21" square and about 1" thick. There were 6 different kinds made, 10 of each kind.

The aggregate was composed of Lehigh Portland Cement, coarse Bank finish sand, and Ohio River pebbles ranging in size from about ¼" to ½". These pebbles are hard rock, mostly flint. Just sufficient water was used to make the finish work properly. The six different kinds of slabs were made as follows:

No. 1. 1 part cement, 1 part sand, 1 part pebbles; the finish surface being kept moist for 10 days after being made.

No. 2. 1 part cement, 1⅞ parts pebbles; the finish surface being kept moist for 10 days after being made.

No. 3. 1 part cement, 2 parts sand; the finish surface being kept moist for 10 days after being made.

No. 4. 1 part cement, 1 part sand, 1 part pebbles; the finish being exposed to the sun and not kept moist.

No. 5. 1 part cement, 1⅞ part pebbles; the finish being exposed to the sun and not kept moist.

No. 6. 1 part cement, 2 parts sand; the finish being exposed to the sun and not kept moist.

The first three kinds had a little rim around the edges on the finished side so that liquids could be retained on the surface. This was neglected in the last three kinds so when being tested an edge was formed with plaster of Paris. After the slabs had cured about two months, each was divided into 25 3-in. squares, with a 1-in. space between each square. This is shown in Fig. 1. The squares were lettered from *A* to *Y*, each slab being treated in the same manner with liquid hardeners, protective paints, etc., a different kind being used in each square.

A, B, C, D, E, F, G, H, K, L were chemical hardeners; *I, T* and *X* were oil hardeners; *M* was linseed oil; *J, N, O, Q, R* and *W* were paints; *P* and *V* were blank acid-proof coatings; *U* was a liquid preservative, *Y* was paraffine, and *S* was a cement floor filler, no paint being added.

A was applied by brushing in with a tooth-brush, the first treatment being 1 part hardener and 1 part water. The surface was kept well flooded, and the scum which came to the surface was scraped off after it became thick. A second coat of the same strength was applied. After the scum was removed, a third full-strength treatment was applied. This was repeated several times, the last being a hot full-strength solution on the lower half of the square.

B, H and *L* were treated like *A* except that the first coat was 1 part hardener and 2 parts water. The second application was 1 part hardener and 1 part water. The third application was 2 parts hardener and 1 part water; sufficient time being allowed to elapse between each application so the floor would be thoroughly dried.

C, F and *G* were applied like *A*.

D was applied like *B* except the first treatment was 1 part hardener, 4 parts water; second treatment, 1 part hardener, 2 parts water, and third treatment, 2 parts hardener and 3 parts water.

E was applied by brushing on one coat of full strength and rubbing off the surface in about 10 minutes.

I was brushed on, allowed to dry and again brushed on, about three coatings being applied.

J was applied in two thin coats, no filler having been previously used.

K was applied like *A* except hot coat was omitted.

M, linseed oil was applied with first coat, 55 per cent turpentine and 45 per cent oil; second coal, 8 parts oil and 7 parts turpentine; third coat, 2 parts oil and 1 part turpentine; fourth coat, straight oil.

N, two coats of floor filler were first applied, followed by a finish coat of paint on the lower half of square.

O, P, Q and *V* were applied in two coats with a third coat on the lower half of the square, no filler being used.

R received one coat of filler and a finish coat of paint and second coat of paint on lower half.

S was applied in two coats at intervals of 24 hours. An extra coat was applied on bottom half of square.

T, U and *X* were applied in three coats.

W, one coat of filler, then one coat paint, and then an extra coat of paint on lower half.

Y, paraffine was heated to a liquid and floor was heated by a blow-torch, the liquid paraffine being run over the surface.

The liquid hardeners appeared to be water solutions of aluminium sulphate, the percentage of the latter being about as follows: *H* 35 per cent, *E* 25 per cent, *D* 24 per cent, *G* 20 per cent, *B* 18 per cent, *L* 17 per cent, *K* 16 per cent, *F* 6 per cent, *A* 4 per cent. These hardeners caused a white scum to occur in varying amounts, the order being about as follows, starting with the one causing the most scum: *A, E, L, F, D, K, C, H, G, B*, the first four causing much more scum than the last six.

The acetic acid used was 55 per cent commercial acid and the other acids were as follows: Commercial sul-

phuric acid, nitric acid 38 deg., commercial hydrochloric acid. The acetic and sulphuric acids, when put on full strength, caused a heavy scum to occur which was washed off before a second treatment, and in all cases two or three treatments of the liquids were used, so that the surface was kept wet for several days. In some instances they dried, however, between applications.

Two applications of sweet milk were applied, the milk being allowed to sour. The first application may have been eaten by a cat as no scum was left, which was the case with the second application.

The sugar solution contained about 1 lb. of sugar to a gallon of water.

The strong acetic acid caused the surface of the concrete to become soft until down below the action of the acid, which was possibly 1/32 in. The action of the strong sulphuric acid removed all visible traces of all the protective applications, and acted uniformly over the entire surface of the test piece. After removing the scum and washing, the surface was soft for a very thin film and very hard under this. The sand did not seem to be loosened, which was the case with the acetic acid, the surface being much smoother with the sulphuric than with the acetic. The hydrochloric and nitric acids left the concrete comparatively soft, about like strong acetic, but took the cement away between the grains of sand and pebbles, leaving a rough surface. The weak sulphuric acid left the surface of the concrete fairly hard. The strong acetic acid caused violent action, leaving a quantity of powder. The strong sulphuric acid also caused violent action, leaving a scum on the surface.

Those specimens treated with strong hydrochloric or nitric acid left the surface of the concrete damp after an elapse of two months. The strong nitric acids seemed to soften up the paints. The milk seemed to have very slight, if any, action on the concrete but tended to soften up the paints, so it would not be advisable to put paint on concrete floors which are apt to come in contact with sour milk.

The sugar solution apparently caused no action on any of the test pieces, the concrete apparently not being affected.

The tests indicate that some of the liquid hardeners and floor paints on the market afford good protection to floors subjected to dilute hydrochloric or dilute acetic acid, and to a lesser extent with dilute nitric or sulphuric acid. Certain paints and cement fillers give good protection against strong hydrochloric; which is not the case with liquid hardeners. Cement floors should not be used where strong sulphuric acid will come in contact with them. Some of the paints and hardeners seem to be much better than others for certain purposes, and will give a certain amount of protection even against strong acetic acid. The sour milk was probably not long enough in contact with the concrete to show what action would occur.

The kind of finish did not seem to have any appreciable effect. However, from experience in actual buildings, I would recommend a mixture of: one part cement, one part coarse sand and one part hard pebbles or crushed hard rock, and would avoid using coarse pebbles without sand mixed with them.

Cincinnati, Ohio.

FIG. 1. SQUARES OF CEMENT UNDER TEST

Alcohol for Motor Fuel in Australia

The London *Times*, Engineering Supplement, Sept. 28, 1917, prints a summary of a report of the special committee appointed by the Commonwealth Advisory Committee of Science and Industry in Australia to investigate the subject of alcohol as a motor fuel. Also a report written by Mr. W. T. Rowe, the chemist to the South Australian Department of Chemistry, and published as Bulletin No. 8 of that department. These reports run on closely similar lines, the main aspects of the problem with which they deal being the design and manufacture of the engine, the supply of alcohol, and the methods of denaturation.

The committee, like Mr. Rowe, begin with a discussion of the advantages of alcohol as a fuel for internal combustion engines, and proceed to explain the reasons that have decided them to devote their attention primarily to the design and manufacture of stationary rather than motor-car engines. They consider that much can be done to familiarize people with the use of alcohol as a fuel by exhibiting alcohol engines at work at agricultural shows and other exhibitions in Australia, and they propose either to purchase or to have constructed an engine or engines for demonstration purposes. In this connection the Secretary of the Alcohol Motor Fuel Committee of the Imperial Motor Transport Council, who are co-operating with the Australian Committee, will be glad to receive at 39 St. James Street, London, S. W. 1., any available information as to the cost of efficient alcohol engines and the probable date of delivery. A small stationary engine of 5 to 10 hp. would be preferred, but if it is impossible to obtain delivery of a suitable engine at a comparatively early date a complete set of plans might be purchased with a view to the engine being constructed in Australia.

PRODUCTION

In the opinion of the Committee the supply of alcohol is likely to prove a much more difficult problem than the design of engines for its use. The most economical source for its production at present is said to be molasses, but even if the whole available supply of molasses in Australia were used for the purpose it would be sufficient for the supply of only about 4,000,000 gallons per annum, whereas the annual imports of petrol

are in the neighborhood of 17,000,000 gallons. The average quantity of molasses available annually in Australia for distillation is about 50,000 tons, of which about 12,500 tons are now used for that purpose. The remainder is largely wasted. The present price of alcohol produced from molasses is about 1s. 9d. a gallon, ex store in Melbourne. It appears unlikely that any considerable quantity can be made in Australia from either raw or waste materials not at present utilized. The most important of these materials are waste timber, grass-tree, prickly pear, waste fruit, and straw. The prospects of producing alcohol from cellulose, such as waste timber or straw, on a profitable basis do not seem encouraging. Failing the utilization of raw or waste materials it will be necessary to grow special materials for the purpose. Of these the Committee regard maize, wheat, barley, potatoes, and beet as the most promising, though they are not yet able to give particulars of the cost of manufacture from these sources.

Mr. Rowe thinks that in South Australia potatoes offer the best prospects, but he points out that the crop in the best years, about 33,000 tons, even if all converted into alcohol, would yield only 760,000 gallons, or less than half the present consumption of motor spirit in the State.

DENATURATION

The Committee states that the denaturants at present required for industrial methylated spirits (2 per cent. of wood naphtha and ½ per cent each of pyridine and mineral benzine) cost 1.74d. per gallon of alcohol, and they regard an alteration in the regulations as desirable if alcohol is to be available at as low a price as possible. Their suggestion that 1 per cent of pyridine only, which would reduce the price of denaturants to 0.9d. per gallon of alcohol, would suffice has not been approved of by the excise authorities. They are collecting data with the object of finding a cheap and efficient denaturant which can be produced in Australia, and they express the hope that the authorities will deal with the whole question in a liberal spirit, since otherwise artificial restrictions in the way of the extended use of industrial alcohol will be greatly increased.

Mr. Rowe also insists that the first step towards the production of alcohol on a large scale is a revision of the excise regulations, so as to provide a system of methylation better adapted to a motor spirit than that now in use. He suggests that benzol or petrol, or both, should be allowed for methylation purposes, and that the redistilled condensate from Pintsch gas manufacture would make a cheap and effective denaturant. This liquid contains a large proportion of benzol, and like it will mix with alcohol in all proportions. It would, he says, certainly fill the bill as far as nauseousness is concerned, and it is a powerful fuel as well.

Personal

Mr. **L. Drew Betz,** formerly chemist with the Animal Oil Company, has been appointed chemical director of the Philadelphia plant of E. F. Drew & Company, Delaware Avenue and McKean Street, Philadelphia, Pa.

Mr. **W. R. Gilard** has resigned from the research staff of the Pittsburgh Plate Glass Co. to become Director of Research for The Lancaster Lens Co.

Mr. **Bancroft Gore,** formerly professor of metallurgy in the School of Mines at Butte, has gone to the Naltagua Smelter at El Monte, Chile.

Mr. **L. O. Howard,** consulting engineer of Salt Lake City, has been appointed Dean of the School of Mines of the State College of Washington at Pullman.

Mr. **G. W. Laurie** of the firm of Drucker & Laurie, 50 Church Street, New York City, has joined the Twenty-third U. S. Engineers.

Mr. **Joseph McKay, Jr.,** for thirteen years with the Wheeler Condenser & Engineering Co. and for the past two years with the Pittsburgh Valve Foundry & Construction Co., has recently been engaged as general sales manager of the Deschanel Engineering Corporation, 90 West Street, New York City.

Mr. **F. G. Moses** has been appointed hydrometallurgist in the U. S. Bureau of Mines, with headquarters at Salt Lake City station.

Mr. **Edwin C. Pierce** of Youngstown, Ohio, has been named consulting chemist for the Republic Motor Truck Co. of Alma, Mich., and has equipped a complete chemical and metallurgical laboratory in that city to handle this and other Michigan work. The laboratory is in charge of Mr. Clyde S. Morgan.

Mr. **H. DeWitt Smith** has resigned his position as assistant manager for the Kennecott Copper Corp. and has accepted a position as superintendent of the Mining Department of the United Verde Copper Company at Jerome, Ariz.

Mr. **A. Gordon Spencer,** formerly chief chemist of the Canadian Inspection & Testing Laboratories of Montreal, has severed his connection with that company and is opening an office at 617-8 Transportation Building, Montreal, as a consulting chemist and metallurgist.

Mr. **H. B. Underwood** has severed his connection with the Buffalo Foundry & Machine Company and has identified himself with the Hewitt Rubber Company, Buffalo, N. Y.

Mr. **W. C. Webster,** who has been secretary and General Manager and Director of the Nichols Copper Company, 25 Broad Street, New York, for several years past, has resigned and withdrawn from the company. Mr. Webster expects to take a rest before assuming further duties.

Book Review

Mineral Industry for 1916. By G. A. Roush, A.B., M.S. 939 pages. Price, $10.00. New York: McGraw-Hill Book Co.

The first volume of the Mineral Industry was published by Richard P. Rothwell in 1893. The present volume, therefore, marks the twenty-fifth anniversary of this work, and during this period the editors have given the public annually complete reviews of the mineral industry, not only of the United States but of the world. The present volume is fully up to the high standard which has been set in the past, and in certain respects is even more complete. The editor is to be congratulated in keeping the size of the volume down to reasonable limits, in spite of the temptation to increase in proportion to the growing importance of the subject. This result is accomplished by reducing the space which has frequently in the past been devoted to papers at the end of the work.

The chapter entitled Mineral Industry, on page 1, by Mr. Roush, introduces a new feature. In this chapter, under the head of General Progress, he gives a number of tables presenting in diagrammatic form the production of the various metallic and non-metallic substances. In each case the world's production and the production of the most important countries is shown. All these diagrams, except in the case of tungsten, cover the periods from 1893 to 1916.

The chapters on Abrasives, Aluminium, Antimony, Arsenic, Asbestos, Asphalt, Barium and Strontium, Bismuth, Borax, Bromine and Iodine, Cadmium, Cement, and Chromium give the production of these various products in the usual manner, also consumption, uses, and, in certain cases, bibliographies.

Coal and Coke are treated extensively, and complete information is given in regard to price, production in this country, and, as far as possible, in foreign countries.

The chapter on Copper is most complete, as it should naturally be, in view of the enormous amount of copper furnished by the U. S. in comparison with the world's production. In 1916 this country furnished 62 per cent of the world's output, compared with 60 per cent in 1915 and 56.4 per cent in 1914. Production in this country in 1916 increased 36 per cent in comparison with that of the previous year. This chapter covers 114 pages, and gives complete statistics of the copper trade, the production of copper in this country, and, as far as possible, abroad, and also includes a very thorough review of the Metallurgy of Copper in 1916.

Then follow short chapters on Cryolite, Feldspar, Fluorspar, Fuller's Earth, Graphite and Gypsum, etc.

Gold and Silver, Iron and Steel, Lead, Petroleum, Platinum, Tin and Zinc are dealt with in detail and full information is given about these metals.

The chapter on Precious Stones is quite elaborate, and covers 30 pages.

The only special chapter is one on Ore Dressing and Coal Washing, in which this subject is very ably discussed.

Last, but not least, is a very full and carefully compiled index, which enables one to find with ease the data desired on any particular subject.

CURRENT MARKET REPORTS

Non-Ferrous Metal Market

Wednesday, Nov. 21.—There is no change in copper and lead. Tin has advanced sharply and spelter has also had a slight advance.

Copper.—There is nothing new in the copper situation and the price remains at 23½ cents as fixed by the government. There seems to be plenty of copper for all needs, but the small consumer is not receiving much and cannot buy much owing to the one price. An investigation of this situation should be made.

Tin.—Tin has advanced sharply. It rose from 72 to 74½ cents from Nov. 8 to 14 and has since jumped to 80 cents for Straits and 72½ for Banka. Arrivals up to Nov. 20 were only 1185 tons with 4100 tons afloat. Probably higher prices than the above mentioned have been paid for small lots.

Lead.—The trust price of lead continues at 6.25 cents New York. Sales have also been made for January, February and March at this figure. Independents have asked 6.50 cents. A good business has been done in lead for some time.

Spelter.—The spelter market has been quiet, although the price has advanced from 7½ to 8 cents over a period of about a week. The producers organized a committee Nov. 13 to co-operate with the War Industries Board in fixing prices. Members of the new committee are Edgar Palmer, chairman, C. T. Orr, Cornelius F. Kelly, C. M. Loeb, Sidney J. Jennings, N. Bruce McKelvie, Charles F. Baker, Walker W. Vick, R. A. Cowles, A. P. Cobb, E. W. Furst, S. M. Evans, J. D. Lang and S. S. Tuthill.

OTHER METALS

Aluminium, lb.	36 –.38
Antimony, lb.	13½ –.14
Bismuth, lb.	3.50
Cadmium, lb.	1.50
Nickel, electrolytic, lb.	.5
Quicksilver, flask.	100.00
Silver, oz.	.80
Platinum	105.00
Palladium, oz.	115.00–120.00

The Iron and Steel Market

Since the announcement of the War Industries Board's third batch of iron and steel prices on Nov. 5, noted in last issue, the general regulation of prices and trade practices in the iron and steel industry has passed, in substance, to the American Iron and Steel Institute, which, after careful work by various committees, has made a number of lengthy announcements as to extras and differentials applying to the basis commodities upon which the War Industries Board set prices, and as to prices for commodities related to the fundamental products for which prices were set. These other commodities are chiefly manufactures of iron and steel. Thus the announcement of skelp prices as well as a basis price for standard steel pipe by the War Industries Board has been followed by the announcement of boiler-tube prices by the institute. Rod prices have been followed by chain prices, bar and rod prices by prices for rivets, bolts and nuts, etc., prices for common sheets by prices for electrical sheets, and so along the line.

Control Working Smoothly

The first thing to be said about this altogether sweeping change in methods of conducting the iron and steel business is that the control is working smoothly, much more smoothly than the great majority had anticipated. Buyers and sellers know precisely what the prices are, so far as the work of setting prices and establishing relations has gone, and in that respect they are much better off. Sellers are clearer in their mind as to what they should sell and what they should not sell, while buyers are clearer in mind as to what they should buy and what they should not buy.

In general, it is possible to buy at the set prices, and for relatively early deliveries, much earlier deliveries in most cases than had been expected. Buyers were afraid that there would not be nearly enough steel, and that they would be left in an embarassing position when they were denied the right of competitive bidding, a right which, as a matter of fact, they had been exercising to their own detriment. Some of them also feared that producers would simply step out of the market and refuse to sell, as in substance their agreement with the Government was not that they would sell to the public

at certain prices but that in case they did sell it would not be at above those certain prices.

These fears have not been realized. The great majority of producers are quite ready to sell to regular customers who can show that they really need material. There would be a still broader sales policy were there not the danger of some consumers seeking to buy at the set prices when they were under contract to take material previously bought at higher prices. It is safe to assert that the great majority of producers are striving earnestly to carry out the full spirit of the price-control arrangement as well as the mere letter.

Pig-Iron Contracts

The blast-furnace men, as a class, have shown a strong desire to "play the game" to the full. Not only do they strain a point to make a sale and guarantee prompt delivery in the case of a customer needing iron, but they stand ready to make contracts for part or all of next year's delivery, under contracts not merely at the set price, but with a proviso that the price is guaranteed against Government change in price as to any unshipped tonnage at the time of the price change. As no one expects that the pig-iron prices will be revised upward, this provision is altogether in favor of the buyer. A very considerable volume of business has thus been put through. The price limit on No. 2 foundry and basic iron, f.o.b. furnace, is $33.

Commercial Requirements Were Decreasing

While it is extremely creditable to iron and steel producers that they have adopted, with such breadth of action and willingness of spirit, the price control, there is no occasion to ignore the fact that the commercial consumption of steel had begun to decrease, and is bound to decrease still more. In many directions, commercial activities involving the consumption of iron and steel are decreasing, and market prospects, from either the price or the tonnage standpoint, are not as good as they were a few months ago, when many were asserting that price control for the entire trade was undesirable, if not impractical.

If it were possible for the steel industry to convert its tonnage of ingots into finished products in any proportions desired, it is altogether improbable that the ingot supply would be sufficient to meet all demands; but on account of the specialization of the rolling departments this cannot be done, and thus it is hardly improbable that steel in all forms will be distinctly scarce. Rather it will be scarce in certain forms only.

Production Difficulties

It has become doubtful whether iron and steel production can be maintained indefinitely during the war at the rate obtaining in the past few months, even though that rate is in the neighborhood of 10 per cent below rated capacities. During the past fortnight the traffic situation has become much worse, particularly with respect to the movement of coke, and pig-iron production is restricted in consequence. The railroads are breaking down under the load, and yet winter weather is at hand, and that always adds to the difficulties.

The Washington authorities are making strenuous efforts to encourage the production of iron and steel, but with indifferent success. Partly to relieve the railroads, and partly to increase the supply of labor for essential war work, there is to be more or less restriction of certain industrial activities. What are to be called "unessentials," in other words, are to be marked for curtailment. The plans are in embryo as yet. One mode of procedure is to debar certain materials from railroad transport, the other being to deal directly with specific industries whereby their activities may be curtailed, and the relative extent to which each method may be prosecuted is not yet clear. The curtailment in the unessentials will affect in certain respects the consumption of iron and steel, but no forecast can be made at this time as to the iron and steel tonnage that may be involved.

Government orders for steel are increasing, and promise to involve a larger tonnage than was expected even a few weeks ago. The shell-steel requirements will be particularly large. This matter is to be judged not by the tonnage of orders being placed but by the activity in seeking manufacturers who will accept orders for shells. Orders are being placed in Canada, and as to the United States the Government is not satisfied with resurrecting the shell factories that in the past were so active in making shells for our present Allies, but is seeking information as to other plants that can be converted for shell manufacture. The total shell-steel tonnage required of the mills, therefore, is likely to be greater than they have produced at any time in the past.

Practically the entire iron and steel market is now under price control, and a few basis prices are quoted: Billets, $47.50; small billets, $51; slabs, $50; sheet bars, $51; rods, $57; bars, 2.90c.; shapes, 3c.; plates, 3.25c.; blue annealed sheets, 10 gage, 4.25c.; black, 28 gage, 5c.; galvanized, 28 gage, 6.25c.; standard steel pipe, 51 per cent off list as basis; plain wire, 3.25c.; wire nails, $3.50; tin plate, $7.75.

Chemical Market

Benzol.—The position is very unsteady, in fact it is weakening day by day. Offerings are freely made and buyers on contract over 1918 are being made inducements, with a possibility of bettering same in the course of a few weeks.

Phenol.—While the position is not as firm, as previously, offerings continue restricted, but the demand is not great and it is predicted that a lower level will prevail shortly.

Toluol.—Governmental authorities have requisitioned all lots of consequence and while manufacturers of necessities are receiving such supplies as will tide them over short terms, there is practically none on the market.

Naphthalene.—The position is fairly well maintained; although it is not as strong as heretofore, offerings are made in only a limited way, with fair consuming interest.

Benzoate of Soda.—The toluol situation has brought about a strong position in this product. Practically all factors are sold up for a month or more and advances have been scored in both the acid and the soda, with probabilities of further advances generally admitted. There is a goodly demand with stocks at a low ebb.

Aniline Oil.—No great demand is prevalent and

offerings are liberally made at an attractive figure, with the position weak.

Beta Naphthol.—The position is unchanged. There is a fair demand with prices holding fairly firm, but there is a plenitude of stock on hand.

HEAVY CHEMICALS.—There has been a noticeable slump in trading in heavy chemicals during the past two weeks. The approach of the year end, together with the unfavorable stock market and slowness of collections, has created a halting tendency. As is usual toward December the question of contracts for the new year is always to the front and this naturally restricts trading in spot and nearby positions. There has been generally a pronounced weakness in most products under this classification.

Caustic Soda.—The speculative element has not been quite so pronounced during the past two weeks, and while the market has held at about the level last reported, it has not been firm by any means. The scarcity of real offers of spot and nearby material has added strength to the market which would not have been apparent otherwise. The product is still under the control of dealers, the works having practically nothing to offer to an ordinary buyer. There has been some business placed over 1918 at the relatively high price of 6.65 for deliveries of several cars monthly over the year.

Soda Ash.—The spot position has not been very firm, but for shipment from the works there has been a lack of genuine offers, and this position has generally been difficult to obtain. Barrels have been scarce and have as a rule commanded a premium over bags out of the usual proportion. Dense ash has been extremely difficult to secure and the country is being scoured for supplies.

Formaldehyde.—In contrast to the general chemical situation the market for this product has been active and has been subject to a sharp advance during the interval, with stocks now reduced to a minimum. Deliveries over next year are restricted, with manufacturers offering to regular consumers only.

Bichromate of Soda.—Under pressure of low prices offered for next year deliveries the spot material has receded, with the natural result that trading has been much restricted and transactions reduced to a minimum. Deliveries over 1918 have been named at 16½ to 17c.

Cyanides.—There have been cheap offerings reported from various out-of-town points. Chicago reported lots of R&H material available there at 45c. Locally, 48 to 52c. was quoted, but the material has not been moving freely into consumption.

Prussiates.—Spot lots of soda have been sold at price concessions, but round lots have held well and the inquiry has been fairly good. Potash on the other hand has been in very good request and there has been considerable quiet buying with prices held firm, although an occasional lot has appeared here or there at some five points or so under the market.

Mineral Acids.—The sulphuric acid situation has been quiet, but it has been very firm and offerings have been much restricted. Probably a half million tons of acid could be sold for a quick delivery to-day if it were available at a price. Both brimstone and pyrites continue scarce and producers and shippers are taking no new business. The cost of landing Spanish sulphur ore at Atlantic coast points is now so high that there is practically no difference between brimstone and pyrites acid prices. Nitric acid rules firm, although nitrate of soda is again much lower. Sulphuric acid and packages are high and the cost of acid laid down at consuming points is close to the 10c. level, even for large quantities. Muriatic acid has been slow in comparison with other acids, but the situation is firm.

Nitrate of Soda.—Resale lots have influenced values to a marked degree and there has been a drop from the high level of 5.10 to the present level of 4.50, at which a large tonnage has been offered the past few days. The production in Chile has been large and the importations into this country have apparently been in excess of the normal consumption.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, NOV. 22, 1917

Acetic anhydride	lb.	1.90	—	2.00
Acetone, drums	lb.	.36	—	.37
Acid, acetic, 28 per cent	lb.	.05¾	—	.06
Acetic, 56 per cent	lb.	.11	—	.12
Acetic, glacial, 99½ per cent, carboys	lb.	.40	—	.50
Boric, crystals	lb.	.14	—	.14¼
Citric, crystals	lb.	.70	—	.71
Hydrochloric, C.P	lb.	.08¼	—	.08¾
Hydrochloric, 20 deg	lb.	.02½	—	.02¾
Hydrochloric, C.P., conc., 22 deg	lb.	.02¼	—	.02¾
Hydrofluoric, 30 per cent, in barrels	lb.	.06¼	—	.06½
Lactic, 44 per cent	lb.	.15½	—	.16½
Lactic, 22 per cent	lb.	.06¼	—	.07¼
Nitric, 36 deg	lb.	.07¼	—	.07¾
Nitric, 42 deg	lb.	.09¼	—	.10
Oxalic, crystals	lb.	.45	—	.46
Phosphoric, 47 per cent-50 per cent	lb.	.07½	—	.....
Picric	lb.	.75	—	.85
Pyrogallic, resublimed	lb.	3.15	—	3.25
Sulphuric, 60 deg	ton	25.00	—	30.00
Sulphuric, 66 deg	ton	36.00	—	40.00
Sulphuric, oleum (Fuming), tank cars	ton	55.00	—	60.00
Tannic, U. S. P., bulk	lb.	1.30	—	1.35
Tartaric, crystals	lb.	.79	—	.82
Tungstic, per lb. of W	lb.	1.80	—	1.90
Alcohol, sugar cane, 188 proof	gal.	5.20	—	5.40
Alcohol, wood, 95 per cent	gal.	1.20	—	1.22
Alcohol, denatured, 180 proof	gal.	.84	—	.86
Alum, ammonia lump	lb.	.04½	—	.05
Alum, chrome ammonium	lb.	.20	—	.21
Alum, chrome potassium	lb.	.26	—	.27
Alum, chrome sodium	lb.	.12½	—	.13
Alum, potash lump	lb.	.08¾	—	.09
Aluminium sulphate, technical	lb.	.02½	—	.03¼
Aluminium sulphate, iron free	lb.	.03½	—	.04
Ammonia aqua, 26 deg. carboys	lb.	.17	—	.18
Ammonium carbonate	lb.	.11½	—	.12½
Ammonium nitrate	lb.	.18	—	.20
Ammonium, sulphate domestic	lb.	.07½	—	7.15
Amyl acetate	gal.	5.25	—	5.40
Arsenic, white	lb.	.16	—	.16½
Arsenic, red	lb.	.65	—	.70
Barium carbonate, 99 per cent	ton	70.00	—	.....
Barium carbonate 97-98 per cent	ton	65.00	—	67.00
Barium chloride	ton	70.00	—	80.00
Barium sulphate (Blanc Fixe, powder)	lb.	.03½	—	.05
Barium nitrate	lb.	.08½	—	.11½
Barium peroxide, basis 70 per cent	lb.	.27	—	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01¼	—	.01½
Borax, crystals, sacks	lb.	.07½	—	.07¾
Brimstone, crude	ton	60.00	—	65.00
Bromine, technical	lb.	.65	—	.70
Calcium, acetate, crude	lb.	.06	—	.06¼
Calcium, carbide	lb.	.08½	—	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00	—	38.00
Calcium peroxide	lb.	1.60	—	1.70
Calcium phosphate	lb.	.30	—	.31
Calcium sulphate	lb.	.....	—	.....
Carbon bisulphide	lb.	.07	—	.07½
Carbon tetrachloride, drums	lb.	.16	—	.16½
Caustic potash, 88-92 per cent	lb.	.84	—	.84½
Caustic soda, 76 per cent	lb.	.07¾	—	.09
Chlorine, liquid	lb.	.15	—	.18
Cobalt oxide	lb.	1.40	—	1.50
Copperas	lb.	.01¼	—	.01½
Copper carbonate	lb.	.45	—	.....
Copper cyanide	lb.	.75	—	.78
Copper sulphate, 99 per cent, large crystals	lb.	.0965	—	.0975
Cream of tartar, crystals	lb.	.55	—	.57
Epsom salt, bags	lb.	.03¼	—	.04
Formaldehyde, 40 per cent	lb.	.18	—	.19
Glauber's salt	100 lb.	1.20	—	1.35
Glycerine, bulk, C. P	lb.	.70	—	.71
Iodine, resublimed	lb.	4.25	—	4.35
Iron oxide	lb	.13	—	.15
Lead, acetate, white crystals	lb.	.17½	—	.19
Lead arsenate	lb.	.16	—	.20
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.09½	—	.11½
Lithium carbonate	lb.	1.50	—	2.00
Manganese dioxide, U. S. P.	lb.	.48	—	.55
Magnesium carbonate, tech	lb.	.10	—	.11
Nickel salt, single	lb.	.14½	—	.....
Nickel salt, double	lb.	.11½	—	.....
Phosphorus, red	lb.	1.70	—	.....
Phosphorus, yellow	lb.	2.10	—	2.15

Potassium bichromate	lb.	.45	—	.46
Potassium bromide granular	lb.	1.35	—	1.40
Potassium carbonate calcined, 85-90 per cent	lb.	.75	—	....
Potassium chlorate, crystals	lb.	.46	—	.48
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium iodide	lb.	2.90	—	3.00
Potassium muriate 80-85 p.c. basis of 80 p.c.	ton	350.00	—	375.00
Potassium nitrate	lb.	.28	—	.30
Potassium permanganate	lb.	3.85	—	4.00
Potassium prussiate, red	lb.	3.00	—	....
Potassium prussiate, yellow	lb.	1.27	—	1.35
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	400.00	—	....
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran.	lb.	.11½	—	12½
Salammoniac, white gran.	lb.	.16	—	.18
Sal soda	100 lb.	1.15	—	1.25
Salt cake	100 lb.	1.50	—	2.00
Silver cyanide, based on market price of silver	oz.	....	—	....
Silver nitrate	oz.	.57	—	.59
Soda ash, 58 per cent. light, flat	100 lb.	3.05	—	3.10
Soda ash, 58 per cent, dense, flat	100 lb.	4.00	—	....
Sodium acetate	lb.	.14	—	.15
Sodium benzoate	lb.	3.00	—	....
Sodium bicarbonate, domestic	lb.	02½	—	.03
Sodium bicarbonate, English	lb.	....	—	....
Sodium bichromate	lb.	.18½	—	.20
Sodium bisulphite, powd.	lb.	06¼	—	06½
Sodium chlorate	lb.	.23	—	.25
Sodium cyanide	lb.	.48	—	.51
Sodium fluoride, commercial	lb.	.18½	—	....
Sodium hyposulphite	lb.	01¾	—	.02
Sodium nitrate, 95%	100 lb.	4.65	—	4.75
Sodium nitrite	lb.	.33	—	.35
Sodium peroxide	lb.	.55	—	.60
Sodium phosphate	lb.	.04	—	.04½
Sodium prussiate, yellow	lb.	.35	—	.37
Sodium silicate, liquid	100 lb.	1.80	—	2.00
Sodium sulphide, 30 per cent crystals	lb.	.02½	—	.03½
Sodium sulphide, 60 per cent, fused	lb.	.04	—	.04½
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.35	—	.40
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.10
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg.	lb.	.21	—	.22
Tin oxide	lb.	.72	—	.73
Zinc carbonate	lb.	.35	—	.38
Zinc chloride	lb.	10¼	—	.11
Zinc cyanide	lb.	.50	—	....
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	.16	—	.17
Zinc sulphate	lb.	.05½	—	.05¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.40	—	.42
Benzol, 90 per cent	gal.	.45	—	.47
Toluol, pure water white	gal.	Nominal		
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.17	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P.	lb.	.19	—	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.10	—	....
Alpha naphthol, distilled	lb.	1.60	—	....
Alpha naphthylamin	lb.	.60	—	.65
Aniline oil, drums extra	lb.	.25¾	—	.26
Aniline salts	lb.	.31½	—	.33
Anthracene, 80 per cent	lb.	.10	—	....
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.80	—	1.85
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid	lb.	2.50	—	2.75
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	7.00	—	8.00
Beta naphthol, sublimed	lb.	.85	—	.87
Beta naphthylamin com.	lb.	2.50	—	2.65
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	3.75	—	4.25
Dinitro benzol	lb.	.34	—	.50
Dinitrochlorbenzol	lb.	.42	—	.44
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.57	—	.62
Dinitrophenol	lb.	.55	—	.62
Dimethylaniline	lb.	.60	—	.65
Diphenylamine	lb.	1.00	—	....
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09¾	—	.10
Naphthalene, balls	lb.	.10½	—	.10¾
Naphthionic acid, crude	lb.	1.50	—	1.75
Naphthylamin-di-sulfonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	....	—	....
Ortho-toluidine	lb.	.90	—	1.00
Orth-nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	4.50	—	5.00
Para-amido-phenol, H. Ch.	lb.	5.25	—	5.75
Paranitraniline	lb.	1.10	—	....
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.25	—	....
Phenol, U. S. P.	lb.	.52	—	.53
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.00	—	13.50
Salicylic acid	lb.	1.35	—	1.38
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	2.50	—	....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	....
Corning, Ohio	bbl.	2.60	—	....
Somerset, Ky.	bbl.	2.40	—	....
Wooster, Ohio	bbl.	2.38	—	....
Indiana	bbl.	1.98	—	....
Illinois	bbl.	2.12	—	....
Oklahoma and Kansas	bbl.	2.00	—	....
Caddo, La., light	bbl.	2.00	—	....
Corsicana, Tex., light	bbl.	2.00	—	....
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	....

Fuel Oil

New York	gal.	.10½	—	....
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans.	bbl.	.70	—	1.55
Texas	bbl.	1.60	—	....
Los Angeles	bbl.	1.45	—	....
San Francisco	bbl.	1.45	—	....

Gasoline (Wholesale)

New York	gal.	.24	—	....
Boston	gal.	.25	—	....
Pittsburgh	gal.	.26	—	....
Chicago	gal.	.21	—	....
Oklahoma	gal.	.23	—	....
San Francisco	gal.	.20	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr.	gal.	.21½	—	.22
Paraffine, .865 sp. gr.	gal.	.18½	—	.19

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida	gal.	.44	—	....
Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.50	—	....
Pine oil, destructively distilled	gal.	.43	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.30	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.32	—	....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.21	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19½	—	....
Wood creosote, ref. f.o.b. Florida	gal.	.30½	—	....

Vegetable and Other Oils

China wood oil	lb.	.22	—	.23
Cottonseed oil, crude	gal.	1.30	—	....
Linseed oil, raw, cars	gal.	1.18	—	1.20
Peanut oil, crude	gal.	1.38	—	....
Rosin oil, first run	gal.	.35	—	....
Rosin oil, fourth run	gal.	.66	—	....
Soya bean oil, Manchuria	lb.	16½	—	.17
Turpentine, spirits	gal.	.51	—	....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	40.00	—	50.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.56	—	.64
Carnauba wax, flor.	lb.	.62	—	....
Cascin	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	....	—	....
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.65	—	.75
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.10	—	.11¼
Rosin, 280 lb.	bbl.	6.95	—	....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	22.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	....
Ferrochromium, per lb. of Cr	lb.	.35	—	.40
Ferromanganese, domestic	ton	250.00	—	....
Ferromanganese, English	ton	325.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 75 per cent, f.o.b. N. Y.	ton	....	—	....
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	250.00	—	....
Ferrosilicon, 50 per cent, contract	ton	100.00	—	175.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.35	—	....
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	7.50
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Antimony ore, per unit		1.60	—	1.75
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton			.90
Manganese ore, 48 per cent and over, per unit	ton			1.20
Manganese ore, chemical	ton			$100.00
Molybdenite, per lb. of MoS_2	lb.	2.15	—	2.25
Tungsten, Scheelite, per unit of WO_3	ton	26.00	—	27.50
Tungsten, Wolframite, per unit of WO_3	ton	25.00	—	26.00
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium Pentoxide, 99%	lb.			10.50
Pyrites, foreign	unit	.16	—	.16¼
Pyrites, domestic	unit	.20	—	....

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The AMERICAN STEEL PRODUCTS CORPORATION, New York. Capital, $1,000,000. To manufacture iron and steel specialties. Incorporators: W. S. Brewster, W. P. Kellett and W. B. J. De Lacey, 233 Broadway.

The AMERICAN ZINC PRODUCTS COMPANY, Warren, Ohio. Capital, $1,000,000. To manufacture zinc sheets and allied products, with proposed plant to be located at Greencastle, Ind. Incorporators: D. W. Kerr, F. W. Stillwagon, W. Manning Kerr and G. P. Gilmer.

The AUTOMOTIVE INDUSTRIAL CORPORATION, New York. Capital, $10,000. To manufacture motor devices. Incorporators: C. Bloom and S. E. Stone, 33 Lincoln Arcade Building.

The BARIO METAL CORPORATION, New York. Capital, $90,000. To manufacture electric furnaces. Incorporators: P. Demiles, N. Herbschleb and H. Jenkins, 31 Park Row.

The BIRCH PAPER CORPORATION, New York. Capital, $100,000. To manufacture paper goods. Incorporators: G. P. Breckenridge, J. E. Lauber and B. Becerra, 11 Wall Street.

The BLACK HAWK LEAD & ZINC COMPANY, Miami, Okla. Capital, $250,000. To operate lead and zinc properties. Incorporators: G. N. Williams and U. S. G. Evans, Miami, and J. P. Gilmore, Tulsa.

The COLUMBIA TIRE & RUBBER COMPANY, Wilmington, Del. Capital, $1,500,000. To manufacture automobile tires and other rubber goods. Incorporators: A. M. Halloran, S. A. Williams and Ferris Giles, Wilmington.

The COMMUNITY CHEMICAL COMPANY, Dover, Del. Nominal capital, $5,000. To manufacture chemicals. Incorporators: L. B. Phillips and J. B. Bailey, Dover.

The COMPOUND SPECIALTY COMPANY, New York. Capital, $50,000. To manufacture chemicals and chemical compounds. Incorporators: S. Baer, 1286 Lexington Avenue; M. L. Schaller, 176 West Eighty-seventh Street, and J. R. Roth, 180 St. Nicholas Avenue, New York.

The CONNECTICUT BRASS FOUNDRY COMPANY, Waterbury, Conn. Capital, $10,000. To operate brass and bronze foundries. The company has recently acquired the Pilling Brass Company, Waterbury, and will operate the plant.

The DELANEY FORGE & IRON COMPANY, Buffalo, N. Y. Capital, $750,000. To manufacture iron and steel products. Incorporators: J. L. Emerson, J. A. Hall and J. T. Dillon, Buffalo.

The DEVOE-SMITH COMPANY, Newark, N. J. Capital, $50,000. To manufacture automobiles. Incorporators: Alonzo DeVoe and Prescott S. Smith, Newark, and Lester A. DeVoe, Ridgewood, N. J.

The ELECTROSYNTH CHEMICAL COMPANY, New York. Nominal capital, $5,000. To manufacture chemicals. Incorporators: J. M. Winston, H. and M. Abrams, 130 West 113th Street.

The ENDURANCE TIRE & RUBBER COMPANY, Wilmington, Del. Capital, $5,000. To manufacture automobile tires. Incorporators: C. L. Rimlinger and F. A. Armstrong, Wilmington, and Clement M. Egner, Elkton, Md.

The EUREKA METALLURGICAL COMPANY, Salt Lake City, Utah. Capital, $50,000. To manufacture experimental apparatus for the separation of lead and zinc carbonates, etc. Incorporators: M. A. McChrystal, Reinold V. Smith, Edward Pike and Thomas McCormick.

The FIDELITY TIRE & RUBBER COMPANY, Jersey City, N. J. Capital, $5,000. To manufacture automobile tires and rubber specialties. Incorporators: Richard Kramer, Clason Point, L. I.; James L. Meltzer, New York, and F. O. Sheehan, New York.

The FORE CHEMICAL WORKS, Jersey City, N. J. Capital, $497,000. To manufacture chemicals. Incorporators: M. W. Alexander, R. E. Breed and U. M. Fleischman, Wilmington, Del.

The GIBSON-CLARKE COMPANY, Indiana, Pa. Nominal capital, $5,000. To manufacture farm machinery and other apparatus. Principal incorporator: Lewis G. Clark, Indiana.

N. Z. GRAVES, INC., Philadelphia, Pa. Nominal capital, $5,000. To manufacture paints and oils. Principal incorporator: Nelson Z. Graves, Philadelphia.

The GREAT NORTHERN OIL & REFINING COMPANY, Oklahoma City, Okla. Capital, $100,000. To construct and operate an oil refining works. Incorporators: J. E. Ireson, W. M. Null and S. K. Bernstein, Oklahoma City.

The GROVE CITY BRASS AND BRONZE COMPANY, Grove City, Pa. Capital, $25,000. To manufacture brass and bronze products. Principal incorporator: T. A. Sampson, Mercer, Pa.

The GUN CORPORATION, New York. Capital, $25,000. To manufacture machine guns. Incorporators: E. J. Nathan, Jr., B. Howie and M. L. Macauley, 128 Broadway.

The HANOVER LEAD & ZINC COMPANY, Miami, Okla. Capital, $160,000. To operate lead and zinc properties. Incorporators: J. J. Strong, C. W. Rice and Rudolph Johnson, Cushing, Okla., and J. T. Dickinson, Edmond, Okla.

The HEALDTON LEAD & ZINC COMPANY, Oklahoma City, Okla. Capital, $100,000. To operate a zinc and lead works. Incorporators: William A. Rodgers, John Mulkey and H. S. Cox, Ardmore, Okla.

The HENDEE WRENCH MANUFACTURING COMPANY, Wilmington, Del. Capital, $200,000. To manufacture wrenches and tools. Incorporators: S. A. Williams and A. M. Halloran, Wilmington.

The INDIAN TOOL COMPANY, Pittsburgh, Pa. Capital, $35,000. To manufacture tools. Principal incorporator: August Weinman, Pittsburgh.

The INGALLS IRON WORKS, Birmingham, Ala. Capital, $250,000. To operate a local foundry for the manufacture of iron and steel specialties. Incorporators: R. I. Ingalls, R. D. Leach, A. L. Gilliland and E. G. Ingalls, Birmingham.

The J. O. JENSEN COMPANY, Geneva, N. Y. Capital, $50,000. To manufacture glass products. Incorporators: J. O. and C. A. Jensen and J. Henle, Geneva.

The KING GLASS COMPANY, Kokomo, Ind. Capital, $100,000. To manufacture glass specialties of various kinds. Incorporators: E. B. King, C. D. Wells and William M. Wells.

The LAWRENCE IMPLEMENT COMPANY, Roanoke, Va. Capital, $30,000. To manufacture agricultural implements of various kinds. Incorporators: J. S. and J. G. Lawrence, Roanoke.

The LIBERTY PHONOGRAPH COMPANY, Brooklyn, N. Y. Capital, $1,500,000, with Delaware charter. To manufacture talking machines. Incorporators: Alfred A. Case, Brooklyn, and Dudley E. Case, Jersey City, N. J.

The LIMITED STEEL PRODUCTS COMPANY, New York. Capital, $60,000. To manufacture steel and iron specialties. Incorporators: S. P. Durenheimer, O. C. Deutscher and F. C. Canfield, 341 Fifth Avenue.

The LITTLE GIANT TRUCK COMPANY, Wilmington, Del. Capital, $50,000. To manufacture automobile trucks. Incorporators: M. M. Clancy, Wilmington and Clement M. Egner, Elkton, Md.

The MAKE-A-TRACTOR CORPORATION OF AMERICA, Wilmington, Del. Capital, $1,500,000. To manufacture motor-driven tractors. Principal incorporator: C. L. Rimlinger, Wilmington.

The MARKLEED CHEMICALS CORPORATION, New York. Capital, $220,000. To manufacture chemicals and paints. Incorporators: L. H. Marks, New York; H. C. Aron, 55 West Tenth Street, New York, and H. M. Wise, Woodcliff, N. J.

The MARREN MANUFACTURING COMPANY, Wilmington, Del. Capital, $500,000. To manufacture machinery and motors. Principal incorporator: F. A. Armstrong, Wilmington.

The MEXOKAKAN OIL & REFINING COMPANY, Tulsa, Okla. Capital, $850,000. To construct and operate an oil refining plant. Incorportors: S. L. Hess, Alva, Okla.; G. T. Nickles and W. H. Sandy, Tulsa.

The MINER-EDGAR COMPANY, Newark, N. J. Capital, $100,000. To manufacture chemicals. Incorporators: Henry M. Miner, James C. Thornton and N. M. Goodlet, Jr., all of Newark.

The MISENER & IRVING MANUFACTURING COMPANY, Syracuse, N. Y. Capital, $50,000. To manufacture tools, etc. Incorporators: J. I. Misener, A. Pearsall and E. V. B. Tyminski, all of Syracuse.

The MORETON ACCESSORIES COMPANY, Wilmington, Del. Capital, $100,000. To manufacture spark plugs and other automobile accessories. Local incorporator: C. L. Rimlinger.

The PROVIDENT MANUFACTURING & CHEMICAL COMPANY, Los Angeles, Cal. Capital, $10,000. To manufacture chemicals. Incorporators: H. C. Hollins, Frank Hollins and D. W. Coons, all of Los Angeles.

The REPUBLIC BAG COMPANY, New York. Capital, $100,000. Incorporators: R. Kest, W. P. Gray and A. Newman, 853 East 176th Street.

Construction and Operation

Alabama

BIRMINGHAM.—The Perfection Mattress & Spring Company is planning to equip a section of its works for the manufacture of wire clothes hangers.

BIRMINGHAM.—The Sloss-Sheffield Steel & Iron Company is making repairs in its No. 3 furnace, and is planning for early operation.

California

LOS ANGELES.—The National Engineering Company, Wilmington, near Los Angeles, has filed plans for the erection of a new one-story machine shop addition to its plant. The structure will be about 45 x 75 ft.

LOS ANGELES.—The Moreland Truck Company, manufacturer of motor trucks, has had plans prepared for the construction of a new one-story addition to its foundry, about 40 x 100 ft., which is to be erected in connection with its new plant at Burbank.

LOS ANGELES.—The Central Machinery Manufacturing Company has had plans prepared for the erection of a new one-story factory building on San Pedro Street. The structure will be about 40 x 125 ft.

LONG BEACH.—The Craig Shipbuilding Company has made application to the City Council of San Diego for permission to construct a new shipbuilding plant near the municipal pier, at a cost of about $500,000.

BRAWLEY.—The City Council is considering the installation of a municipal electric power plant. George R. Wade is city engineer.

SAN DIEGO.—The Savage Arms Corporation has taken over the plant of the Independent Sash & Door Company, Market Street, and is planning for the installation of new machinery to specialize in the manufacture of guns.

VENTURA.—The Ventura Manufacturing Company, specializing in the manufacture of agricultural implements, is planning to increase its output by the erection of a new plant, site for which is now under consideration near Torrance. Upon completion of the new works, the company will remove its entire business to the new location.

SAN LUIS OBISPO.—Ravens, Aleg & Hammer, Los Angeles, have secured the property of the old local whaling station and are planning for the construction of a plant for the manufacture of potash. The site is located on the north side of San Simeon Bay, and two barges are now at work securing kelp for conversion into potash.

ANTIOCH.—Mason Bros. of Sausalito have secured 90 acres of land, and will erect $500,000 plant for manufacture of potash, acetone, sulphate of ammonia, etc.

Connecticut

NEW BRITAIN.—Bids have been taken by Landers, Frary & Clark, manufacturers of electrical appliances, for the immediate construction of a one-story addition to their plant, about 50 x 325 ft. The structure is estimated to cost about $25,000.

YALESVILLE.—Fire recently destroyed a portion of the two-story factory building of the Connecticut Screen & Cabinet Company. The loss is estimated at about $6,000, and it is said that the destroyed part will be immediately rebuilt. Charles H. Cheeney and Charles A. Runge head the company.

Delaware

NEW CASTLE.—The Bethlehem Steel Company has been awarded a large contract by the Government for projectiles, and it is expected to give employment to about

3000 additional hands at the projectile manufacturing plant of the company, south of the city.

WILMINGTON.—The Pusey & Jones Company has taken bids for the erection of a new one and five-story foundry, pattern works and storage shop at its shipbuilding works, foot of Poplar Street, to cost about $150,000.

WILMINGTON.—The Asbestos Auto Hood & Capsule Container Company, recently incorporated in Detroit, Mich., is planning to purchase a local site of about twelve acres for the construction of a plant to be devoted to the manufacture of automobile hoods and bodies, compressed asbestos and capsule containers for the shipment of high explosives. Property a short distance from the city limits is now under consideration. The new plant will give employment to about 1000 hands. James M. Cutheil, Charles Milligan and Robert T. Beyer, all of Detroit, head the company.

WILMINGTON—The General Chemical Company has commenced the construction of a block of thirty-nine dwellings for the workmen employed at its plant. The buildings are to be erected along the Philadelphia turnpike at Claymont, and the company is planning for the erection of one hundred and forty houses in all.

Florida

JACKSONVILLE.—The Brooks-Scanlon Lumber Company has acquired the saw mill of the Carpenter-O'Brien Lumber Company at Eastport, and is planning to double the capacity. The company will also erect a large new pulp and paper mill to have a capacity of about 100 tons of kraft paper daily.

MORRISTOWN.—The Acme Phosphate Company, Chicago, Ill., is planning for the construction of two new addtions to its local plant, about 40 x 200 ft. and 30 x 150 ft. The company, which has heretofore operated the works for the washing of hard phosphate exclusively, will utilize the new buildings for the purpose of preparing and marketing double crop soft phosphate in addition to its hard phosphate output. Machinery for the new plant has been ordered, including dryers, tube mills, conveyors and steam power plant equipment.

PENSACOLA.—The Pensacola Fertilizer & Oil Company has acquired a site on Town Point, across the bay, for the construction of a new plant for the production of fertilizer and oil from menhaden, a small fish found in abundance in Gulf waters, by special process. The machinery for the new plant has been ordered and will be installed immediately upon completion of the works. C. H. Munger is president of the company.

Illinois

CHICAGO.—The Apex Electric Manufacturing Company, Fifty-ninth Street, has had plans prepared for the construction of a new one-story addition to its plant. The structure will be about 25 x 50 ft.

CHICAGO.—The Ehman Tire & Rubber Company, 144 West Twenty-seventh Street, has awarded a contract for the erection of its proposed new two-story and basement addition, about 50 x 100 ft. J. L. Carnegie & Son, 189 West Madison Street, Chicago, is the contractor. The structure will cost about $50,000.

CHICAGO.—The Great Western Smelting Company, Forty-first Street, is planning for the construction of a new one-story machine shop, about 100 x 100 ft., at Whiting, Ind.

EAST ST. LOUIS.—The St. Louis Coke & Chemical Company, recently incorporated with a capital of $15,000,000, has had plans prepared for the construction of a large new plant on a site of 250 acres of land now under consideration, and will engage in the manufacture of metallurgical coke from Illinois coal. The blast furnace unit of the works will consist of three furnaces with a capacity of 500 tons each. Smelting of iron ore will be done in conjunction with the carbonizing of coal, and hot metal will be supplied to the steel plants in the vicinity, which will afford a great saving in the consumption of pig iron heretofore brought in from northern and southern districts. The by-product of the coke plant will be gas, tar ammonia products, toluol xyol, benzoin, solvent naphtha, etc. The works, which will give employment to about 1200 hands, will, when completed, represent an investment of approximately $10,000,000.

Indiana

GARY.—The United States Steel Corporation has inaugurated operations in its new 160-in. plate mill just completed. Work is being rushed on the new plate mill now in course of construction at South Chicago, and it is expected that the plant will be completed before the close of the year.

SOUTH BEND.—The Studebaker Corporation, manufacturer of automobiles, is making rapid progress in the construction of a new local plant, which, when completed, will cost about $2,000,000. The work includes the erection of a new machine shop, four-story dry kiln, a forge shop, and a large power house for plant operation.

Kansas

WICHITA.—The Liberty Pipe Line & Refining Company is planning for the construction of a 3-in. pipe line from the A-1 pool, Wichita, to Douglass. The company is also planning for the erection of a new refinery to handle the product of the A-1 Oil Company in Butler County.

Kentucky

WINCHESTER.—The French-Agnew Torpedo Company, Zanesville, Ohio, is considering the erection of a large local plant for the manufacture of nitroglycerine.

Louisiana

GRETNA.—The American Cotton Oil Company, New Orleans, is planning for the construction of a new local plant to be devoted to the production of glycerine from cottonseed oil.

MONROE.—Alton Brown and associates, Pittsburgh, Pa., have acquired a site of about 700 acres and are planning for the construction of a new plant for the production of carbon, to cost approximately $200,000. The site is on the location of the R. L. Moore tract, a few miles northeast of Monroe.

SHREVEPORT.—The Henderson Cotton Oil Company, recently incorporated with a capital of $400,000, has completed the construction of its new plant, which has a daily capacity of 200 tons of seed. The new works represent an investment of about $150,000.

Maryland

BALTIMORE.—The Standard Oil Company has had plans prepared for the construction of a new five-story addition to its plant at Pratt and Penn Streets, about 38 x 130 ft. Blanke & Zinc, Equitable Building, Baltimore, are the architects.

Massachusetts

ATHOL.—The Athol Manufacturing Company has commenced the construction of two new additions to its plant. The new structures will be two-story, brick, about 40 x 96 ft., and one-story brick, 30 x 120 ft. The company manufactures pneumatic rubber goods, etc.

BOSTON.—The Safepack Paper Mills, manufacturers of waterproof paper, have completed the construction of their new plant at Millis, and have removed their entire business to the new location.

LYNN.—The Lynn Rubber Goods Manufacturing Company, manufacturer of rubber heels, soles, etc., has acquired a site in Clifton, R. I., and is planning for the erection of a new plant to provide for increased capacity.

SALEM.—The Salem Oil & Grease Company is making rapid progress in the erection of a new addition to its plant, and is planning to install new tanks and machines for preparing oils for leather tanners.

SOMERVILLE.—The Gile Marine Engine Company is making rapid progress in the construction of a new one-story machine shop, about 60 x 100 ft., to cost approximately $8,000.

SPRINGFIELD.—The Springfield Aircraft Corporation is rushing to completion the construction of the new addition to its plant on Wason Avenue. The structure will cost about $50,000.

Michigan

BUCHANAN.—The Campbell Transmission Company, 133 West Washington Street, Chicago, Ill., is planning for the construction of a new local manufacturing plant, one-story, about 60 x 230 ft., to cost $45,000. Davidson & Weiss, 53 West Jackson Boulevard, Chicago, are architects.

DETROIT.—The Guardian Motors Company has acquired property on the eastern branch of the Elizabeth River, Norfolk, Va., and plans for the erection of a large plant for the manufacture of automobiles. The initial works will consist of a reinforced-concrete structure, 100 x 500 ft., with temporary works, to be erected immediately, 50 x 100 ft. The proposed plant will have a total capacity of about 3000 cars annually. R. E. Mitchell, Norfolk, is architect.

SAGINAW.—The Northwestern Glass Company has acquired the plant of the Michigan Glass Company on Wheeler Street and will install new machinery for the manufacture of glass containers, jars, bottles, etc. It is expected to inaugurate operations before the close of the year.

Minnesota

MINNEAPOLIS.—Rapid progress is being made in the construction of the new benzol plant of the Minnesota Steel Company, and it is planned to commence operations before the close of the year.

WEST DULUTH.—The Zenith Furnace Company is having plans prepared for the construction of a new fireproof machine shop at its plant on Fifty-eighth Avenue, West. The structure is estimated to cost about $50,000.

New Jersey

CHROME.—The United States Metal Refining Company has acquired the property of the International Nickel Company, Tuffts Neck, Carteret, consisting of about 120 acres, and is planning for the erection of a new plant to provide for increased capacity. The site was secured for a consideration of about $1,200,000.

FORDS.—The National Synthetic Company, Fords, near Perth Amboy, has awarded a contract to Tullis & Blanchard, 326 East Forty-second Street, New York, for the construction of three new additions to its chemical manufacturing plant, about 38 x 260 ft., 54 x 84 ft., and 50 x 76 ft. Estimated cost of the structures is $75,000.

ELIZABETH.—The Guilmette-Underwood Brass Foundry Company has inaugurated operations at its new location, 160 East Jersey Street. The company will manufacture brass and aluminum moldings, and engage in metal pattern work.

ELIZABETH.—The Barrett Company, manufacturer of roofing and building paper, tarvia, roofing and paving pitch, carbolic acid, and other coal tar products, has acquired the plant and business of the All Roofing Company, East St. Louis, Ill., and is planning for the erection of additions to the works to provide for increased capacity.

NEWARK.—Elmer & Amend, 211 Third Avenue, New York, manufacturers of chemicals, etc., have acquired a factory building at 13-17 Margaretta Street, Newark, and are planning for extensive alterations and improvements. The company is also erecting a new building at Third Avenue, between Eighteenth and Nineteenth Streets, New York, which will cost about $150,000.

NEWARK.—The National Oil & Supply Company, 180 Frelinghuysen Avenue, has filed plans for the construction of a new brick and steel addition to its plant in Essex Street, to cost about $15,000.

NEWARK.—The Western Manufacturing Company has been organized to operate a plant at 615 South Nineteenth Street for the manufacture of wood chemicals.

NEWARK.—The Osborne Company, 759 Summer Avenue, manufacturer of art calendars, etc., has acquired property on Hallech Street, about 86 x 190 feet, and is said to be planning for additions to its plant.

NEWARK.—Louis Sachs, operating a foundry on Hamburg Place for the production of semi-steel castings, has awarded a contract for the erection of an addition to his plant.

NEWARK.—The Veks Rubber Company, 15 Kirk Place, has been organized to engage in the manufacture of erasers. Charles F. McChesney heads the company.

NEWARK.—The Heller & Merz Company, Hamburg Place, manufacturer of colors, dyes, etc., has awarded contracts for the erection of two new one-story brick factory buildings, about 70 x 200 ft., to cost $56,000.

NEWARK.—The Brown-Ferres Company, Inc., manufacturer of phenacetine and other chemicals, has acquired a two-story reinforced-concrete factory building on Meadow Lane from the Ezo Company. The company is planning for the immediate erection of a new building about twice the size of the one just acquired.

PATERSON.—The American Shell Company, 350 Twenty-first Avenue, has taken out a building permit for the construction of a one-story addition to its plant to cost about $13,000.

PERTH AMBOY.—The Raritan Copper Works has completed the construction of a new two-story addition to its plant, about 41 x 101 ft., and is planning for immediate occupancy. The new structure is estimated to cost about $24,000.

TRENTON.—The Delion Tire & Rubber Company is having plans prepared for extensions and improvements in its plant to cost about $18,000. J. Osborn Hunt, Trenton, is architect.

TRENTON.—The Zee-Zee Rubber Manufacturing Company has had plans prepared for the construction of a new plant at

Yardville to cost about $500,000, and the works will consist of one-story mill building, about 50 x 200 ft.; two two-story factories, 50 x 160 ft. and 40 x 125 ft., respectively; and another one-story building, about 60 x 190 ft. The company is planning for a daily capactiy of about 900 automobile tires and 5000 inner tubes.

New York

BROOKLYN.—Herman Behr & Company, 33 Tiffany Street, have awarded a contract for the erection of an addition to their sandpaper manufacturing plant to cost about $8,000. Meyer & Sweeny, 384 Crown Street, Brooklyn, is the contractor.

BROOKLYN.—Beckers Aniline & Chemical Works, Inc., East Eighty-third Street, is making rapid progress in the construction of new additions to its plant in the flatlands section. The estimated cost of the extensions is about $1,100,000.

NEW YORK.—The Stackpole Carbon Company, 71 West Broadway, has awarded a contract for the construction of a new one-story retort house, about 50 x 100 ft., at Mary's, Pa., to cost $30,000. The W. L. Goeltz Company, 50 Broad Street, New York, is the contractor.

COOK'S FALLS.—Fire recently destroyed a portion of the plant of Bine Brothers, with loss estimated at about $8,000. The company specializes in the production of sulphur colors.

GENEVA.—The United States Lens Company, manufacturer of spectacle lenses, etc., is planning for the construction of a new one-story addition to its plant, about 65 x 180 ft., to cost about $35,000. C. E. Wilson is president of the company.

MIDDLE FALLS.—A new three-story mill building, about 65 x 212 ft., will be erected by the Stevens & Thompson Paper Company at a cost of $75,000. Contract has been awarded to the Kingsbury Construction Company, Main Street, Hudson Falls.

BUFFALO.—The Great American Chemical Products Company has taken out a building permit for the construction of a new two-story reinforced-concrete factory building, about 30 x 60 ft., at South Park Avenue and Colgate Street.

BUFFALO.—The Donner Union Coke Corporation is making rapid progress in the construction of its new plant in the 150-acre site on the Buffalo River, recently acquired.

Ohio

SANDUSKY.—The Sandusky Glass Manufacturing Company, West Monroe Street, is making extensive improvements in its plant to provide for increased capacity.

TOLEDO.—The Lewis Foundry Company, 4080 Detroit Avenue, specializing in the production of valves of all sizes, has reincorporated with a capital of $100,000 and will be known as the Lewis Steel Products Company. Two new additions to the plant have recently been completed and the company is planning for additional extensions to provide for the constantly increasing demand. At the present time the company has a daily capacity of about 15,000 gas and gasoline engine valves.

TOLEDO.—The Toledo Plate & Window Glass Company, 1014 West Eleventh Street, has acquired property on St. Clair Avenue, east of East Thirtieth Street, at a price of about $60,000, as a site for a new plant, which will be erected at a cost of $150,000. The initial construction will comprise three units to be used as finishing works, warehouse and office building. Plans are being prepared by Walker & Weeks, 1900 Euclid Avenue. George L. Heater is general manager.

TOLEDO.—The Scott Machine Company has filed plans for the construction of a new one-story machine shop, about 60 x 166 ft., at West Fourteenth Street and Locust Avenue, N. W., to cost $23,000. Contract has been awarded to the William Dunbar Company, Toledo.

Oklahoma

BRISTOW.—Fires will soon be started in the new plant of the Bristow Glass Company, just completed, which will specialize in the manufacture of glass bottles. This is the second largest glass manufacturing plant in the State.

OKLAHOMA CITY.—The Miami National Lead & Zinc Company, recently incorporated with a capital of $200,000, is planning for the erection of a new 300-ton mill on a site of 80 acres, and is planning to develop about 1000 acres of land early in 1918. O. L. Parry, 110 West Grand Street, Oklahoma City, is president.

PICHER.—The Fort Worth Lead & Zinc Company, Fort Worth, Tex., is planning for the construction of a new local 2-ton concentrating plant, and will develop 20 acres of land now held on lease.

Pennsylvania

HARRISBURG. — The Pennsylvania Bronze Foundry, Seventh and Camp Streets, will build a new foundry at Seventh and Emerald Streets. The structure will be one-story brick, about 150 x 240 ft.

HARRISBURG.—The Atlantic Refining Company has secured the building of the Pennsylvania Bronze Foundry, at Seventh and Camp Streets, and will use the structure to provide for increased capacity.

NEW KENSINGTON.—Fire recently destroyed a portion of the plant of the United States Aluminum Company, a subsidiary of the Aluminum Company of America, Pittsburgh. The loss is estimated at $175,000. The plant was engaged in the manufacture of bronze powder for the Government.

PHILADELPHIA.—Contract has been awarded for the construction of a new plant at Aramingo Avenue and Huntingdon Street for John T. Lewis & Brothers Company, manufacturers of paints, etc. The works will consist of three-story mill building, brick and concrete, about 40 x 120 ft.; furnace building, 120 x 220 ft.; and one-story brick warehouse. The entire plant is estimated to cost $150,000.

PHILADELPHIA.—George D. Wetherill & Company, 114 North Front Street, manufacturers of paints, varnishes, etc., have taken out a building permit for an extension to their plant.

PITTSBURGH.—Powell & Mahan have had plans prepared for the construction of a new one-story foundry, about 45 x 150 ft., at Tulsa, Okla. The plant will be devoted to the production of brass and semi-steel castings.

SOUTH ALTOONA.—Ground has been broken by the Pennsylvania Railroad for the construction of a new plant for the purpose of mixing the lubricating oils, greases and signal oils for lines east of Pittsburgh. The plans provide for the erection of thirty-one steel storage tanks, with capacity ranging from 1000 to 125,000 gallons.

Rhode Island

PROVIDENCE.—The Providence Gas Company is perfecting arrangements to greatly enlarge one of its workshop buildings at Fields Point. The additions will provide for about 10,000 additional square feet of floor space.

Tennessee

KINGSPORT.—The Clinchfield Portland Cement Corporation has commenced work on the construction of a new potash recovery plant. The new works will employ the Cottrell or electrical precipitation system in its latest form, and will include a wet treater, by means of which potash salts will be obtained. Richard K. Meade & Company, consulting engineers, Baltimore, Md., are the designing and constructing engineers for the plant.

MUSCLE SHOALS.—Contract for the erection of the proposed new nitrate plant for the United States Government has been awarded to the J. G. White Company, 43 Exchange Place, New York.

Texas

DALLAS.—Fire recently destroyed a portion of the building of the Southwestern Paper Company's South Texas branch at Houston, with loss estimated at $75,000. It is said that the structure will be immediately rebuilt.

HOUSTON.—The Sinclair Gulf Corporation has announced that a large new oil refinery, with pipe lines and auxiliary facilities, will be constructed immediately just below Harrisburg. The refinery is estimated to cost about $6,000,000 and it is proposed to spend a total of $11,000,000 for the entire works, including all improvements. The refinery will consist of four units, and will have an initial capacity of 20,000 barrels of oil daily, being ultimately increased to 40,000 barrels daily. H. F. Sinclair is president of the company.

Utah

MIDVALE.—The Utah Iron & Steel Company has completed the construction of its new open-hearth steel plant and is planning to inaugurate operations at an early date. This includes the installation of a large electric furnace. The entire works represent an expenditure of about $250,000.

PROVO.—The Springville-Mapleton Sugar Company has acquired a site south of Springville and is planning for the immediate erection of a large sugar plant. Jesse Knight is president of the company.

SALT LAKE CITY.—The Shelley Roller Mills Company has completed the erection of its new plant and is now installing the necessary machinery. It is expected that operations will be inaugurated before the close of the year. The new mill has been constructed at a cost of about $75,000.

Virginia

BUSH BLUFF.—The Standard Oil Company is planning for extensive additions and improvements in its supply station near Norfolk, to cost approximately $2,000,000.

NORFOLK.—The Norfolk Chain Company, recently incorporated with a capital of $1,000,000, has completed plans for the construction of its proposed new plant for the manufacture of heavy chains. The works will comprise a factory building, 90 x 560 ft., and a structure about 60 x 300 ft. The main building will be equipped with hammers for welding chains, and testing machines, with auxiliary equipment. Contracts have been awarded. This company is a subsidiary of the American Chain Company of Bridgeport, Conn.

NORFOLK.—The Norfolk Tire Fabric Company is planning for the erection of a large plant, which with machinery and other equipment is estimated to cost $1,000,000. The company will specialize in the manufacture of automobile tire fabrics.

Wisconsin

EAU CLAIRE.—Rapid progress is being made in the construction of the new one-story paper mill, about 72 x 80 ft., by the Dells Paper & Pulp Company.

MILWAUKEE.—The Standard Steel Corporation, manufacturer of farm implements, is planning for the construction of a new one-story brick, concrete and steel factory building, about 60 x 200 ft., to cost about $35,000. The new addition is to provide for increased capacity.

New Publications

CHROMITE IN 1916. By J. S. Diller. Mineral Resources of the United States, 1916, Part I, pp. 21-38, U. S. Geological Survey, Washington, D. C.

BAUXITE AND ALUMINUM IN 1916. By James M. Hill. Mineral Resources of the United States, Part I, pp. 159-170. U. S. Geological Survey, Washington, D. C.

THERMOELECTRIC MEASUREMENT OF CRITICAL RANGES OF PURE IRON. By Geo. K. Burgess and H. Scott. Scientific Paper, Bureau of Standards, No. 296. Washington, D. C.

MINES AND MINERAL RESOURCES OF CALIFORNIA. (a) Alpine, Inyo and Mono counties; (b) Butte, Lassen, Modoc, Sutter and Tehama counties; (c) El Dorado, Placer, Sacramento and Yuba counties; (d) Los Angeles, Orange and Riverside counties; (e) Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura counties; (f) San Bernardino and Tulare counties. State Mineralogist, Ferry Building, San Francisco, Calif.

SCIENCE REPORTS OF THE TOHOKU IMPERIAL UNIVERSITY. Prof. T. Hayashi, Librarian, Sendai, Japan. Miscellaneous contributions on mathematics, physics and chemistry, including among others, Some Properties of Annealed Steel, Transformations of Steel at High Temperatures, and Magnetic Properties of the Manganese-Antimony Alloys.

Manufacturers' Catalogs

THE COLORADO IRON WORKS COMPANY, Denver, Colo., has issued pamphlet No. 32, describing the Lowden patent dryer.

THE NEW YORK REVOLVING PORTABLE ELEVATOR CO., Jersey City, N. J., has issued Bulletin No. 42, entitled "How to Pile," describing the use of the revolvator for piling cases, bales, barrels, crated machinery, etc.

THE TITANIUM BRONZE COMPANY, INC., Niagara Falls, N. Y., has issued an attractive booklet on titanium aluminum bronze die castings.

THE WEBER SUBTERRANEAN PUMP COMPANY, New York City, has issued a catalog, entitled "Pumping Water by Compressed Air."

THE ESTERLINE COMPANY, Indianapolis, Ind., has issued a bulletin describing its graphic efficiency instruments.

THE DUST RECOVERING & CONVEYING COMPANY of Cleveland, Ohio, has just issued Bulletin No. 1, describing its "Perfecto" Suction Filter, used for the recovery of solids from gases of furnace smelters, blast furnaces, and for dust-collecting in general.